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annual report
1902-03 & 1903-04

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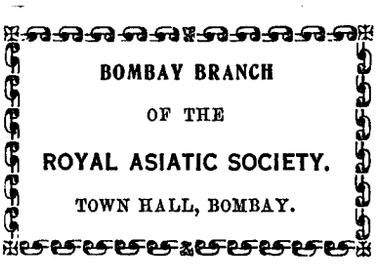

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ANNUAL REPORT

OF THE

BOARD OF SCIENTIFIC ADVICE FOR INDIA

FOR THE YEAR

1902-1903.

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In compliance with the order conveyed in Government of India Resolution No. 22—16-2, dated Simla, the 28th August 1902, paragraph 8, the Board of Scientific Advice herewith submit, as their Annual Report, a brief review of the results obtained in all lines of scientific investigation in or regarding India for the year 1902-1903 based upon the Annual Departmental Reports submitted to the Board and upon papers published by individuals.

I. **Trigonometrical Survey.**—The Triangulation party of the Survey of India was employed in completing the Manipur Minor Meridional Series, extending it southward over the Kyaukpyu Yomahs, in the neighbourhood of Mount Victoria. The work was completed and a very satisfactory junction effected with two stations of the Burma Coast Series. It has proved of the utmost use to the Forest Surveys of the Chindwin Valley and the series will be a very valuable one in aiding the extension of topographical and other surveys.

II. **Topographical Survey.**—1. BURMA. A party of the Survey of India has been employed in Lower Burma mainly in surveying blanks omitted from cadastral surveys, but also in revising and completing the topographical detail obtained from the reductions of cadastral sheets. The work was carried on in the districts of Pegu, Hanthawaddy, Tounghoo, Thayetmyo, and Prome; 1,905 square miles of detail survey was completed on the 1-inch scale and 350 square miles on the 2-inch scale, while the revision of sheets prepared from cadastral reductions has been carried on over an area of 1,048 square miles. The usual triangulation in advance has been carried out in addition. Another party of the Survey of India worked to the west of Long. 96° 30′ in revising and adding to maps produced by reducing cadastral sheets; 4,100 square miles were thus completed and revised. The large-scale maps of the town of Maymyo were also revised and brought up to date. Two amalgamated parties surveyed 2,663 square miles in the Southern Shan States along the west of the Salween river. Some surveyors worked also across the Salween to the eastwards, filling up and amending older reconnaissance survey sheets which had been surveyed on the $\frac{1}{4}$-inch scale.

2. UNITED PROVINCES. A party of the Survey of India took up the topographical survey of Allahabad and other districts of which no maps existed. The work has consisted mainly of traversing in preparation for future detail survey; 1,985 square miles were thus prepared and a detail survey mapped of 203 square miles.

3. PUNJAB. A party of the Survey of India mapped 3,000 square miles of the Montgomery and Lahore districts; its work consisted chiefly in utilizing

the large-scale *patwari* maps of the Punjab, compiling and completing from these, by work in the field, a topographical map. The village trijunctions of the districts have all been fixed by a professional traverse, so that means are available for combining the reduced *patwari* maps, which then only require to be checked and completed in the field, the main points requiring to be supplemented being the river-banks and village-sites. Besides this topographical work, riverain traverses were carried on for the Local Government. The Simla estate boundary survey was continued during the open season and a few hundred square miles of country in the Simla Hill States were also surveyed.

4. SIND. A party of the Survey of India surveyed 1,597 square miles of British territory in Sind on the 2-inch scale and 4,556 square miles of the more desert part of the Khairpur State on the reduced $\frac{1}{2}$-inch scale; the usual triangulation in advance was also carried out.

5. MILITARY. A party of the Survey of India was employed on work required by the military authorities. This party surveyed 2,787 square miles in Kashmir and 1,696 square miles in Sind. In addition it surveyed eight cantonments and bazaars in the Bengal Command and completed a large area of frontier reconnaissance.

6. SAMBHAR LAKE SURVEY. A survey of the Sambhar Lake was taken up by the Survey of India at the instance of the Northern India Salt Revenue authorities, in connection with the research by the Geological Survey into the source of supplies of water in the Sambhar Salt Lake in Rajputana, Lat. 27°N., Long. 75°E.

The survey consisted of a preliminary triangulation of the area to be surveyed, followed by a detail survey on the scale of 2 inches to a mile combined with a series of spirit-levelled lines run along the edge of the lake and across it in lines about 2 miles apart with another line as nearly as possible longitudinally down the centre of the lake. In addition a small series of triangulations was afterwards run, connecting up eight of the bench-marks of the levelling operations on the edge of the lake with the stations in the preliminary triangulation. Astronomical observations for latitude and azimuth were taken at Sambhar station. The area triangulated is about 228 square miles with 9 stations and 57 intersected points. The lengths levelled were 53 miles in preliminary circuits, 83 miles of cross lines in the lake-bed, and 34 miles of extra lines, in all 170 miles. The height of the starting bench-mark close to the salt offices at Sambhar was determined by spirit-levelling from the adjacent Sambhar secondary station which is only about 100 yards away. In addition to the principal bench-marks, 9 wooden marks were fixed in the centre of the lake on the cross-lines. They consist of wooden planks 2 feet × 1 foot × 1 inch, screwed across the top of the posts, painted black and white. These posts will serve also as water-gauges, as bands were painted round them at even feet, *viz.*, if the level of the top was found to be 1183·65 then the bands were painted at 1183, 1182, etc.

The levelling in the lake was very difficult, as the bed for the most part consisted of soft sticky mud in which the observers sometimes sank over their knees. In order to make the level steady, a plank 12 inches square by 1 inch deep with a small hole in the centre was put under each log, and these planks were kept from slipping outward by long wooden stakes driven into the mud. The observer had these wooden planks to stand on, radiating out from a centre under the instrument through the spaces between the legs. The staff was held on a large tent-nail driven in the centre of the plank, and the plank was pressed in the mud till the top of the nail was level with the top of the mud.

The topography extended to a distance of a mile inland from the edge of the lake, except to the south-east, where a large portion was surveyed so as to include the Kobarsina range of hills and the Julga lake. Clinometric heights were taken at nearly every fixing; all the big hills were shown with 100 feet contours, but the low ground was not contoured, only heights being shown. The depth of the water in all the wells was ascertained. The resulting map will enable the volume of water in the lake to be ascertained at any time.

7. TIDAL OPERATIONS. These were continued by a party (No. 25) of the Survey of India, observations being recorded for 13 stations.

8. LEVELLING OPERATIONS. These were carried on for a portion of the season on the Eastern Bengal State Railway, a connection being made with the

Sonakhoda Base-Line. A commencement of levelling was also made in Assam and arrangements made to do the same in Burma.

The total outturn of topographical survey for the year amounted to 8,801 square miles of new survey and 10,054 square miles of topographical revision survey. Of these areas, 11,677 square miles were surveyed and revised on the 1-inch scale and 7,141 square miles on the 2-inch scale; 23 square miles were surveyed on the 4-inch scale, and 54 square miles were surveyed on the 6-inch scale.

The topographical surveys in Burma, by filling and completing blanks in cadastral surveys, rendered useful a number of maps that otherwise were fragmentary and, owing to the omission of hills and other topographical details, were meaningless. They were also useful by replacing the maps of the ½-inch scale reconnaissance survey which was commenced as soon as Upper Burma was occupied. That survey, like all reconnaissance surveys, varies in accuracy and in fullness of detail according to the facilities which the surveyors at the moment had for traversing the country, and according to the time at their disposal. In its present state this reconnaissance survey is not sufficiently complete, even if its scale were found adequate, to serve military requirements; the scale is unquestionably too small, even if the survey were sufficiently accurate, to meet the needs of the Civil Administration or to assist the various Departments of Government. The riverain traverses of the Punjab districts afford the means of fixing once for all their riverain boundaries. The survey of the Sambhar Lake supplies the fundamental information essential for the further enquiries of the Geological Survey and the Salt Department.

III. Forest Survey.—1. Bombay. Surveys were carried on in the forests of the Northern, Central, and Southern Circles; in addition to triangulation and traversing, 607 square miles of detail survey were mapped on the 4-inch scale and 161 square miles on the 8-inch.

2. Madras. The survey of the forests in Kurnool, Cuddapah, and South Canara on the 4-inch scale was continued; the area surveyed was 1,306 square miles.

3. Burma. In the Upper Chindwin, Minbu, Pyinmana, and Ataran districts, 724 square miles of forest-reserves were surveyed; 274 square miles of forests were also surveyed in the Ruby Mines district. A large forest area, principally in the Upper Chindwin, Minbu, and Thayetmyo districts, was also triangulated and traversed in advance for the subsequent detail survey.

4. Central Provinces. In Mandla 699 square miles of forests were surveyed, and in Chanda 725 square miles were surveyed, on the 4-inch scale.

5. Bengal. In Singbhum 369 square miles of reserved and protected forests were surveyed on the 4-inch scale; and 58 square miles on the same scale were surveyed in the Koderma forests.

6. Punjab. In the Jubbal and Taroch State forests an area of 100 square miles was surveyed on the 4-inch scale; a small area of 12 square miles was also surveyed in Hazara.

The total outturn of forest surveys was 5,035 square miles; 4,874 square miles being on the 4-inch scale and 161 square miles on the 8-inch scale.

The survey of the Koderma forest in Bengal was chiefly made for the purpose of locating the mica mines.

IV. Cadastral and Traverse Surveys.—1. Burma. In the Lower Chindwin district 545 square miles were surveyed in detail; in the Sandoway district 120 square miles. In the Pakkôko district 911 square miles, in the Sandoway district 16 square miles, and in the Kyaukpyu district 145 square miles were traversed preparatory to detail survey.

2. Assam. In Assam 133 square miles of extensions of cultivated areas were traversed to serve as a basis for local cadastral survey; 94 square miles of tea-grants were also traversed.

3. Bengal. In the districts of Darjeeling, Monghyr, Purnea, Bhagalpur, Gaya, Backergunge, Sonthal Parganas, Singbhum, and Ranchi 4,171 square miles were traversed, 2,132 square miles were cadastrally surveyed, and record-writing for 2,078 square miles was completed. Small Government estates in Patna have been traversed; surveys connected with the relaying of boundaries of other estates have been carried out in Malda, Champaran, Shahabad,

Monghyr, and Darbhanga; and a boundary in Jalpaiguri has been permanently marked.

4. United Provinces. In Etah district 181 square miles were traversed; 2,507 square miles were cadastrally surveyed in Azamgarh, Mainpuri, Etah, and Jalaun.

5. Central Provinces. A number of small scattered areas consisting of excised portions of forest-reserves have been traversed in Damoh, Hoshangabad, Chhindwara, Nimar, Chanda, Raipur, Sambalpur, Mandla, and Seoni; the total area aggregated 715 square miles. A disputed boundary was also traversed in the Chhindwara district.

6. Madras. The parties engaged in forest survey operations carried out the preliminary triangulation and traversing of the Godavari delta in preparation for a 16-inch cadastral survey.

The total areas traversed amounted to 6,366 square miles; those cadastrally surveyed to 5,304 square miles; record-writing was completed for 4,585 square miles.

V. **Geographical Surveys and Reconnaissances.**—These include surveys and reconnaissances on the $\frac{1}{2}$-inch or smaller scales. In Sind and Kashmir 4,556 square miles were surveyed on the $\frac{1}{2}$-inch scale and 7,938 square miles were surveyed on the $\frac{1}{4}$-inch scale. In the Shan States and on the North-West Frontier 63,000 square miles were surveyed and reconnoitred. A survey paty was attached to the Aden Boundary Commission.

VI. **Marine Surveys.**—A party of the Marine Survey of India completed a sketch survey of the Megna river. The examination showed that considerable alteration had taken place in the river since the previous sketch survey of 1884 and demonstrated the inadvisability of making a detailed survey. No deep channel was found to exist and the river was reported as dangerous for any but craft of very light draught on account of the strong tides, heavy bores, and constant changes in the river-bed.

On the Tenasserim coast the Marine Survey were able to undertake and complete the coast survey from Button Island to Toby Rock, with soundings off to a distance of 10 miles. This was charted off on a scale of 1 inch to the nautical mile, thus connecting the survey of Moulmein (1898-99) with that of Ye (1887). An attempt was made to discover a navigable channel into the Hinzé basin, but a preliminary examination showed that such a survey as would be of service must involve more time than could be spared from the survey of the Chittagong coast, which is of the first importance to navigation and can only be undertaken for a limited part of the surveying season. A party of the Marine Survey was engaged in making a survey of Cox's Bazaar which was completed on a scale of 4 inches to the mile and thereafter was employed on the survey of Naaf river port on the 3-inch scale; with this work good progress was made. The main survey party reached Naaf river on January 11th and the heavy swell which had set in on the coast rendered landing to mark the coast in the usual manner quite impossible. This, however, it was found could be dispensed with since sufficient points, given by the Grand Trigonometrical Survey, could be located to admit of fixing the position of the survey ship with accuracy. Natural marks abound on this part of the coast and these, with the help of a few Beacon buoys, provided ample data for sounding and also for coast-lining with sufficient accuracy for all practical purposes; only very small indentations and creeks are possible as discrepancies. Notwithstanding unfavourable weather, 60 miles of coast, reaching as far south as the Asirgah shoal, with soundings off it to a distance of 10 miles, were charted by the 13th March. After this date it was inadvisable to continue on the Arracan coast, and the R.I.M.S. *Investigator* proceeded to the Andamans to survey on a scale of 4 inches to the nautical mile a portion of the coast omitted in 1889 between Δ Bay and Shoal Bay. This was rendered necessary owing to the difficulty experienced by the Commissioner of the Andaman Islands in inducing ships to load timber at uncharted ports and the consequent expense involved in towing logs to Port Blair. The coast survey between South Point of Andaman, Middle Strait, and Yaratang was completed, with the exception of an inlet at the back of Shoal Bay which is navigable only for small craft.

VII. Survey of India and Marine Survey Head-quarters work.—An entirely novel method of taking a whole map in one reversed negative and printing it direct upon the zinc, known as Heliozincography, worked out in the photographic branch of the Survey of India is a decided improvement on any of the older methods of map reproduction; work is now turned out more quickly and the results are sharper and freer from distortion.

In the Survey of India considerable progress was made with the new 32-mile map of India. A railway- and canal-map on this scale was completed and printed off, as were six small maps of India prepared for the Report of the Census Commissioner for India. Among the numerous maps in progress reference may be made to a telegraph map on the 32-mile scale and another on the same scale for the Railway Mail Service.

The recess work of the Marine Survey of India included a resurvey of the entrance to the Government wet basin at Bombay on the scale of 25 inches to the nautical mile and the publication of charts of the Chittagong river on the 6-inch scale and of the river Megna on the ½-inch scale.

The following publications were issued by the Survey of India during the year:—

(1) *General Report on the operations of the Survey of India during* 1901-1902.

(2) Professional Paper No. 5. *The attraction of the Himalaya mountains on the plumb-line in India.*

(3) Professional Paper No. 2 of 1902. *Account of a determination of the co-efficients of expansion of the wires of the Jäderin Base-line apparatus.*

(4) Professional Volume xvi. *Details of the tidal observations taken during the period from* 1873 *to* 1892 *and a description of the method of reduction.*

(5) Synoptical Volume xxix. *Great Arc Meridional series, section* 8° *to* 18°.

(6) Addendum to Synoptical Volume xxxiii. *Cutch Coast Series.*

By the Marine Survey of India were published:—

(1) *Administration Report of the Marine Survey of India for* 1902-1903.

(2) *Illustrations of the Zoology of the R. I. M. S.* "Investigator." *Crustacea,* Pt. x; Plates LVI—LXVII.

In connection with the Marine Survey, however, it is necessary to allude to the publication, during the year, of *A naturalist in Indian seas, or Four years with the Royal Indian Marine Survey Ship* "Investigator," by Major A. Alcock, M.B., LL.D., F.R.S., a former distinguished officer of this survey.

VIII. Astronomical work.—1. Astronomical Latitudes. These were observed by the Survey of India at stations on the Calcutta meridional series and Darjeeling triangulation. The results are very interesting and remarkable; the zone of positive deflection extends very much closer the foot of the hills than was expected and the transition from a positive deflection to a large negative one takes place with startling rapidity.

The work at the Madras Astronomical Observatory under the Meteorological Department included the determination of mean local or Madras time and its distribution to the port and town of Madras and to all the large telegraph offices throughout the Empire.

2. Solar Physics. The routine work laid down for the Kodaikanal Solar Physics Observatory for the year included the daily visual observation of the most widened lines in the sunspots, six of such lines being observed between F and b and six between b and D; the noting of other widened lines; the record of visual observations of the prominences and chromo-sphere. In addition photographs had to be taken by the Hale-Dislandres method, and when possible also photographs of sunspot spectra.

The usual routine of Solar Photography was carried on at Dehra Dun by the Survey of India throughout the year. The instrument was the Dallmeyer 8-inch photo-heliograph. The routine is to take two negatives of the sun on every clear day, one as a rule in the morning and one later in the day; on

Sunday only one is taken. The plates are now sent direct to Sir Norman Lockyer, South Kensington.

In all 477 negatives were taken on 299 days; 66 days being missed, some in March and April, owing to haze, and the greater number in June, July, August, and September, owing to clouds. On those taken, spots and feculae appeared on 177 days, feculae alone on 75 days, spots alone on 10 days, and neither spots nor feculae on 37 days; 179 negatives were taken on wet-plates developing with iron and intensifying, and 298 on dry plates; all on Cadett's Lantern plates using Hydroquinine developer.

It was not found necessary to employ the 12-inch photo-heliograph regularly during the year; it is, however, always kept in working order.

IX. **Magnetic Survey.**—The base stations at Colaba, Dehra Dun, and Kodaikanal were available and field-work was therefore commenced in the south of India, as well as continued in the area to the west of the line joining the first two base stations. Five field-detachments were employed in addition to a sixth party under an officer in charge; of these, three detachments worked for considerably less than the full season as they had to be kept back till the observers were fully trained. The five field-detachments completed observations of dip, declination, and horizontal force at 207 stations in addition to 32 old stations which had been observed at during the previous season with partially unsatisfactory results. The officer in charge re-observed at five repeat-stations visited during the previous season, and also at four new repeat-stations. He also took comparative observations at the three base-stations. The whole of the results during this second season of the survey were of an accurate order and show a marked improvement on those previously obtained.

In July and August 1903 a third set of Watson's magnetographs was erected at the new observatory at Barrackpore. This set is similar to those at Dehra Dun and Kodaikanal and consists of declination and horizontal force magnetographs only. A vertical force magnetograph for the Dehra Dun observatory is shortly expected, and sanction has been given for the purchase of three more of these instruments for Barrackpore, Kodaikanal, and Rangoon. At the latter place it is hoped that the declination and horizontal force instruments will be erected in a few months, but the date of their arrival in India is still uncertain. During the past season all fixed instruments were compared with the standards at Dehra Dun at the commencement and close of the field-operations, and this procedure will be continued in future as far as possible.

Sir A. Rücker, F.R.S., having made certain recommendations for the immediate preliminary reduction of results, with a view to avoiding breaks in continuity of the field-work, the best methods by which this may be done have been taken into consideration, and it is hoped that the scheme may be put into effect during 1904. During the coming season one observer will work in and complete the area west of the line joining Dehra Dun and Bombay; two observers will, it is hoped, complete the area west and south of the railway line between Bombay and Madras, and the two remaining observers will work over those railway systems west of the Calcutta meridian which have not been hitherto traversed. The officer in charge will revisit the nine repeat-stations already fixed and observe at eight new stations besides making the usual comparisons at the four existing base stations. Useful magnetic observations have been made during the year by the Marine Survey with Kew unifilar magnetometer and dip circle at Chittagong, Akyab, Moulmein, and Port Blair, parts of India for which reliable magnetic information is altogether wanting.

X. **Meteorology.**—1. OBSERVATORIES. At the commencement of the year 236 observatories furnished meteorological data. Of these 186 were departmental observatories; 50 were non-departmental, maintained by various Native States. At the end of the year the total number of observatories was 240, the number maintained by the Government of India being increased to 190. Of these observatories 7 are first-class, supplied with autograph recording instruments; 38 second-class, recording observations thrice daily; the remainder third-class, recording observations at 8 A.M. daily only. Rainfall was, in addition, registered at about 2,400 raingauge stations, maintained and controlled by Provincial Governments, but subject to the general supervision of the Meteorological Department and recording and publishing the data in accordance with

general instructions issued under the authority of the Government of India. Information of the amount, distribution, and time of occurrence of the snowfall was obtained in the Himalayan and Afghan mountain-area; the information for the cold weather of 1902-1903 was on the whole fairly complete; that obtained from Chamba and Bushahr through officers of the Forest Department, from the Meteorological Reporter, Kashmir State, and from the district officers of Kangra and of the frontier districts was of especial accuracy and value. Observations on mountain meteorology were made in the observatory at the summit of Dodabetta peak, 8,640 feet above sea-level, in Southern India.

2. WARNINGS AND FORECASTS. Daily weather reports illustrated by charts were issued at Simla for the whole of India; daily reports were issued at Calcutta for the Province of the Bengal and the port of Calcutta; at Bombay, for the Presidency and port of Bombay; at Madras, for the Madrs Presidency. Daily press telegrams were also sent from Simla to 16 officials and 12 newspapers.

Storm warnings were given to ports on the Bay of Bengal by the Meteorological Reporter to the Government of Bengal and to ports on the Arabian Sea by the Simla Meteorological Office. Flood warnings were sent chiefly from the Simla office, throughout the year, to various district officers and to officers of the Public Works, Railway, and Irrigation Departments. The number of officers so warned from Simla during the year was 68; the number of special warning messages was 759. The number of officers warned by the Bengal Reporter was 17, chiefly in the Province of Bengal.

Officers warned transmit annually to the Meteorological Department a brief return of warnings received and report whether the warnings were timely and satisfactory. Opinions were received from 45 officers of whom 41 stated that the warnings had been timely and satisfactory. It was reported from Balasore that the transmission of many telegrams had been delayed; from Rawalpindi and from both the right and left bank of the Indus that the warnings of heavy rain and floods received during the year had not arrived in time to be of much practical value. In certain districts of India, but particularly in the Punjab, it is very difficult to forecast with approximate accuracy the occurrence of heavy rain more than 12 to 24 hours before its actual occurrence.

Seasonal forecasts of the probable character and distribution of the south-west monsoon rainfall and the cold-weather rainfall were prepared and issued in accordance with the instructions of the Government of India.

About 427 sets of storm observations were submitted by 37 observers during the year. In addition, a large number of special observations of various kinds were taken by certain observers for the information and use of the department, chiefly in connection with the work of storm and flood warning. The majority of the observations on storms referred to hot-weather thunderstorms, hailstorms, and duststorms. For these storms and special observations amounts varying from one to sixty rupees were awarded. The comparatively small number of storm observations submitted during the year was due in part to the comparative absence of cyclonic storms in India and in part to greater strictness in the assignment of rewards, which are now only granted for observations of real value for the investigation of the phenomena and distribution of the different classes of storms that affect weather in India.

3. MARINE AND EXTRA-INDIAN OBSERVATIONS. Meteorological data were collected throughout the year from vessels entering the ports of Calcutta and Bombay, the barometers on board the ships from which the data were obtained being carefully compared by means of secondary standards in order to ascertain the corrections to be applied to the readings extracted from the vessels' logs. The number of logs extracted was at Calcutta 1,164, at Bombay 877; the number of barometric comparisons made was at Calcutta 4,074, at Bombay 3,938.

Pilot charts showing mean pressure, mean direction, and force of wind, mean surface currents and ordinary tracks of cyclones in the month under review were prepared monthly; the chart for each month was issued about the 20th of the month preceding the period to which it referred.

Observatories at Jask, Teheran, and Ispahan at the telegraph offices of these stations on the Indo-European telegraph line furnished valuable information. Daily weather telegrams were received at Karachi from Bushire and

Jask throughout the year and from Ispahan and Teheran throughout the cold weather. These were most useful in forecasting the approach of cold weather storms from Persia to Northern India.

Weekly telegrams were received during the south-west monsoon from the departmental observatories at Zanzibar and the Seychelles and also from the Royal Alfred Observatory, Mauritius. These gave valuable information, during the monsoon period, of the weather conditions in the Indian Ocean.

Very important information as to the meteorological conditions antecedent to the south-west monsoon was received from South Africa, Cairo, Zomba, and Brisbane.

4. PUBLICATIONS. The chief publications of the Meteorological Department issued since the preparation of the Annual Report of the Board of Scientific Advice for 1902 have been:—

(1) *Report on cloud observations and measurements at Simla, during the period, June* 1900 *to January* 1902, *by* W. L. Dallas, Esq., Sceintific Assistant to the Meteorological Reporter to the Government of India.—Indian Meteorological Memoirs, Vol. XV, Part II.

(2) *Summary and a brief discussion of observations of the clouds recorded at six stations in India, during the period* 1875—1900, *by* Sir John Eliot, M.A., F.R.S., K.C.I.E., Meteorological Reporter to the Government of India and Director-General of Indian Observatories.—Indian Meteorological Memoirs, Vol. XV, Part II.

(3) *Monthly normals of air pressure reduced to* 32° F. *and constant gravity*, Lat. 45°, *by* Sir John Eliot, M.A., F.R.S., K.C.I.E., Meteorological Reporter to the Government of India and Director-General of Indian Observatories.—Indian Meteorological Memoirs, Vol. XVI, Part I.

XI. **Seismography.**—Seismological observations were recorded by the Meteorological Department for the Seismological Committee appointed by the British Association by means of Milne's self-registering seismograph during the year at Alipur (Calcutta), Colaba (Bombay), and Kodaikanal. The records were regularly transmitted to this Committee, those of the chief disturbances were in accord at all three stations. Apparatus has been introduced at Colaba to measure the vertical movement of the ground and its actual tilt.

The question of tidal periodicity in the earthquakes of Assam has been dealt with by Mr. R. D. Oldham, of the Geological Survey of India, in a paper read during the year before the Asiatic Society of Bengal. From the facts observed in connection with these earthquakes the author draws the following conclusions:—

1. That there was a very large variation in the diurnal distribution of earthquakes in Assam during the years 1897—1901, shocks being more frequent between 10 and 11 P.M. and again between 6 and 7 A.M. This greater frequency is a real one and not due merely to a larger number of shocks happening to be recorded at those times. No satisfactory cause can be assigned for these irregularity of distribution, which must for the present be accepted as a fact true for a limited period and area.

2. Superimposed on this large and unexplained variation in frequency, there is a smaller variation which has the appearance of being due to tidal stresses set up by the attraction of the sun.

3. If this smaller variation be really due to tidal stress, then the horizontal stress is much more efficient than the vertical stress and the effect is less due to the amount of the stress than to the rate and range of its variation.

4. That these conclusions must be taken as purely provisional and require verification from a more extended series of observations. For their verification we require an instrumental record from some station within or near the tropics, where earthquakes are fairly frequent, and extending over 19 to 20 years.

XII. **Geological Survey.**—1. ASSAM. The Geological Survey of the Khasia and Jaintia Hills was extended on the 1-inch scale over parts of sheets 29, 30, 42, 43, 44, reducing by 500 square miles the ground left unsurveyed. The accepted relationships of the formations surveyed have not been modified by this work. But a small coal-bearing formation, near the headwaters of the Um

Rileng, 11 miles north of Shillong, discovered since the submission of the last Geological Survey report and at first announced, on account of the peculiar nature of its coals, as cretaceous, is now doubtfully given a post-tertiary age by its discoverer, who has found on tracing the rocks further westward, where the cretaceous rocks are typically developed, that the lithological dissimilarity between the new beds and the cretaceous is so great that he now doubts his original correlation. On account of the imperfectly consolidated character of the Um Rileng beds, he is inclined to regard them as comparatively recent in age. But the age of the formation must remain, in the absence of fossils, undetermined.

2 BALUCHISTAN. The question as to the age of the Takatu mountain near Quetta has now been definitely settled. Some years ago a carefully detailed survey of the ranges made it evident that the massive limestone, forming the main line of peaks with a scarped face to the south-east and a dip-slope to the north-west, does not really overlie the cretaceous rocks of the lower ranges to the south-east, but has been brought into its place by an overthrust fault. The opinion as to its eocene age upheld for many years by previous observers could no longer, therefore, be maintained. Some fossils showing mesozoic affinities were also found, but not sufficiently characteristic for a more precise determination of the age. Now, however, several localities have been met with where the fossils are more plentiful, the most abundant of all belonging to two species of *Spiriferina*. These fossils occur in a thick series of shales and flaggy limestones, extensively developed in several parts of Baluchistan, and of an age which cannot be later than liassic. In normal sections they always underlie the great formation appropriately named "the "massive limestone" in whose uppermost strata callovian fossils have been described. It is the latter rock, and not the nummulitic eocene limestone, that forms the most conspicuous portion of the Takatu.

3. BURMA. During the course of the geological survey of the Lower Chindwin district, special attention was paid to the peculiar crater-like hollows occurring in the tertiary rocks. These hollows have precipitous sides and are sometimes a mile or more in diameter, occasionally including small lakes of salt-water; in one case near Laske there were three confluent hollows, with low cross-ridges of volcanic ash between them, making a depression 1½ miles long, and reaching, in the central and deepest hollow, 150 feet below the general surface of the country. The materials in the country around include fragments of andesitic lava mixed with blocks derived from the tertiary beds; but unmistakable volcanic tuffs are found near by, lying on the pliocene sandstones, the original shapes of the accumulations having been modified by recent erosion. There are eleven of these curious pit-craters in the district, arranged along a line running about north-east to south-west for a distance of 13 miles, thus suggesting their connection with some tectonic fissure which, however, has not been otherwise suspected or proved. They were evidently formed after the cessation of the normal volcanic activity known to have occurred in the area, and were possibly produced by sudden and violent explosions of gases, not followed by ordinary volcanic ejecta, but beginning and ending abruptly.

From the geological survey work done in the Northern Shan States few indisputable conclusions have been obtained with regard to the stratigraphical characters of the country. The collection of fossils made during the past four seasons have now been sent to England for critical examination, and until they are accurately determined the question of correlation of the systems in Upper Burma with those on the European standard scale must be kept in abeyance. A premature discussion of this question of correlation has obscured the actual observations and has retarded the work of mapping the local natural groups of strata, which should be recognized and mapped, apart from the question of equivalence with the recognized systems of Europe. No system of strata in India is coeval, beginning and finish, with any one in Europe, and the use of European terms should follow, not guide, the work of outlining formations on our maps. Whether a system of strata be palæozoic or mesozoic, the essential characters which give it an individuality as a system should be delineated and mapped and that work will represent so much positive progress whether its exact age can be determined or not. In spite, however, of this discussion, the detailed lithological and stratigraphical description of the country has led to a

recognition of certain of the groups with pronounced individuality, and the work which has been done in mapping, describing, and collecting from these, represents solid progress. The formations as to which there is no possible doubt have been outlined, and large collections of fossils have been made.

Three new sheets, Nos. 239—241, have been covered, work partially done has been completed on sheets 285—287 and on sheets 332 and 333, while parts of sheets 331, 379, and 380 have been covered. A traverse has also been made through the Ruby Mines district, and, as far as the thick jungle would permit, the courses of several bands of the crystalline limestones, in which the ruby is found, have been mapped.

4. CENTRAL INDIA. The services of an officer of the Geological Survey were lent for the field-season to the Dhar Durbar, and a detailed survey of the Nimanpur Pargana, generally known as the Dhar Forest, was made by this officer with the assistance of a second. The most important amongst the questions settled by this survey is the age of the sandstones and conglomerates, formerly regarded as part of the Lameta series of rocks, deposited on the old Gondwana continent before it was overwhelmed by flows of Deccan trap in uppermost cretaceous times. Later writers on the area came to the conclusion that some exposures of the sandstones regarded as Lameta probably belonged to the Gondwana system, and hopes were consequently entertained of finding coal in this area. The formation is fairly constant in consisting of an upper division in which the prevailing sandstones are associated with shales and calcareous beds resting on a lower division of conglomerate of well-rounded pebbles embedded in clay or loose sand or cemented by calcite, oxides of iron, or manganese. Throughout the greater portion of the area examined during the season this formation is unfossiliferous; but near Barwaha in Holkar territory, the conglomerate contains typical Bágh (cretaceous) fossils. The fossiliferous conglomerate is lithologically identical with that which everywhere else in the area underlies the supposed Gondwana sandstone and here also actually underlies the sandstone previously regarded as Gondwana. It is quite clear therefore that Blanford's original correlation of these beds with the Lametas was correct. His conclusions, based on lithological similarities, have now been confirmed by observed continuity of the sandstone and conglomerate without fossils to the sandstone and conglomerate with unmistakable cretaceous forms. It follows also from these observations that the Lameta and the Bagh series are of the same age, the former being the deposits laid down in fresh water on the Gondwana continent, whilst the latter are those formed at the same time in the adjoining sea. The Barwaha exposure thus indicates approximately the easternmost limit of trespass by the cretaceous (cenomanian) sea.

The work of this survey has also added to our knowledge of the physical geography of the old land area which was overwhelmed by the great Deccan lava-flows. Where atmospheric agents have cut through the protecting envelope of trap, the old weathered surfaces of the Lameta series have been exposed, showing ferruginous and manganiferous laterites, like those of modern times, and revealing the old irregularities of surface due to river action in cretaceous times. The filling up by lava-flows of the old ravines cut in the Lameta sandstones has led some previous observers to incorrect conclusions with regard to the relative ages of some exposures of Lameta sandstone and adjoining trap. Near Chandgarh, for instance, where the Narbada cuts through a thick conglomerate bed, the latter, on account of its high level, was formerly taken to be a sub-recent accumulation in the river-valley; but the survey officer who crossed the exposure early in the season was struck by the absence of basalt and agate pebbles amongst the boulders that one would expect in a conglomerate formed at the expense of the Deccan trap; on examining the exposure more critically later on it was found that the apparent higher position of the conglomerate was due to the Deccan trap having filled in a deep valley in the Lameta beds.

The recognition of a cretaceous age for these beds, formerly regarded as sub-recent, leads to a suspicion that the same may be true of similar deposits in other parts of India, for instance, those situated in the so-called alluvial diamond-workings of Bundelkhand. These may not be recent alluvial deposits; more probably they are lately uncovered patches of the Lameta: this conclusion, if established, will have an important bearing on prospecting operations in Central India.

Observations which give us glimpses of the old cretaceous landscape which was obliterated by the great lava-flows do more than satisfy geological curiosity. The Deccan trap has protected the mineral wealth of the continent for over 200,000 square miles, and it probably hides more coal than that which has escaped the uninterrupted ravages of the weather in the parts of the country exposed throughout the subsequent tertiary era. The valuable seams of coal, for instance, accidentally exposed by the notch cut out of the trap in the Pench Valley in the Central Provinces gives an indication of what is still hidden below.

5. KASHMIR. The Palæontologist to the Geological Survey was deputed to Kashmir to enquire into the relations of the permo-triassic rocks to those which, in the Salt Range and in the Central Himalayas of Spiti and Kumaon, have proved so interesting palæontologically.

Among the results of this survey, the discovery of the fossil ferns *Gangmopteris* and *Glossopteris*, in beds apparently below permian marine strata, has an important bearing on the geological age of the Lower Gondwana beds in Peninsular India, for which the geological survey, led in this question by Blanford, relying on the accuracy of their stratigraphical work and on purely indirect evidence, insisted on a palæozoic age. Direct and positive proof was, however, wanting; but if Dr. Noetling has correctly read the facts recorded in Kashmir, the final point has now been established.

The discovery was made at Khunmu in the Vihi Valley, 15 miles south-east of Srinagar, where a series of volcanic beds are covered in order by beds of quartzitic sandstones and unfossiliferous limestones on which shales containing remains of *Gangmopteris* were found, followed conformably by chert beds and a calcareous shale with further remains of *Gangmopteris* associated with a ganoid fish of permian affinities and fragments of a skull of *Archegosaurus*. There is then a break in the observations due to the slopes being covered by talus deposits, and the next beds exposed, dipping in the same direction, and presumably following the plant-bearing bed without a break, contain *Fenestella* with other *Bryozoa*. The *Fenestella* beds are covered by limestones with *Spirifer Derbyi*, *Productus indicus*, and other well-known Salt Range fossils, which conclusively proves the permian age of the beds. Accepting the observer's opinion that the gap in the exposures could not possibly hide a fault, the section described shows by direct evidence from marine fossils that the *Glossopteris* flora did actually exist in India in permian times.

6. MADRAS. The part of the Vizagapatam hill-tracts examined embraces the lower plainward edge and fringe of the 3,000 feet plateau lying to the north and south of the Salur-Jeypore Ghât road, included in sheet 108 of the Atlas of India, also the greater part of sheet 93 S. E. A route traverse was made across sheet 93 N. E. and a visit was paid to the manganese mines of Kodur. The result of the survey has been the discovery of nothing but crystalline rocks and unfossiliferous old strata, probably of Cuddapah age. The main groups of the crystalline rocks in the Vizagapatam hill-tracts have now been outlined, only two small patches being left to survey.

The rock groups fall naturally in four main bands which with their north-east to south-west trend determine the physical contours of the country. The north-western band, parallel to and adjoining Bastar State, forms a country which is, generally speaking, a flat plateau, or set of two or more plateaux, ascending by steps from 800 feet in the south-west end to over 1,000 feet in the north-east near Jeypore. With a fairly well-marked scarp and a rise of about 1,000 feet, the boundary of the next band of rocks is marked sharply off from the former, but grades on its south-east side into the third band. The second and third together form a rough hilly country traversed by flat open valleys. The south-eastern edge of the third band forms a well-marked scarp traversed by ghâts as the rapid drop occurs from the 3,000 feet plateau to the fourth band which forms the plains to the east.

The large mass of crystalline rocks in these bands contains the usual great variety of lithological types. As of exceptional interest may be mentioned a band of elæolite-syenite gneiss found near Koraput,—the second instance of the presence of this interesting rock-group in Peninsular India, the first being at Sivamalai in Coimbatore; also a rock-band, traced for some 30 miles from Guda to Sampangputi, a prominent constituent of which is sapphirine, a

mineral which has only been found in one other locality, Fiskarnäs in Greenland.

7. PUNJAB. The Palæontologist to the Survey was deputed to accompany Professor E. Koken, of Tubingen, on a tour through the Salt Range. The short notes submitted by the officer so deputed include references to two important conclusions that require further detailed support; one of these is as to the position of the salt-marl, the other as to the origin of the salt-range boulder-bed.

8. PALÆONTOLOGICAL WORK. A catalogue was made of the tertiary *Foraminifera* from Sind and Baluchistan, with especial attention to the *Nummulites* which are of unusual assistance in correlating the Lower Tertiaries of these provinces with those of the standard scale in Europe. Taking eight of the more important species which are common to Europe and India, we obtain the following correlation scale for the nummulitic formations in the Sind-Baluchistan area:—

Sind and Baluchistan.	European Stages.
LOWER NARI with *N. intermedia*	Priabonian.
Unconformity	Bartonian.
UPPER KHIRTHARS (with the Ghazij and Spintangi of Baluchistan) containing *N. perforata*, *N.* (*Assilina*) *granulosa*, *N.* (*Assilina*) *exponens*.	Lutetian.
Unconformity	.....
UPPER RANIKOT:—	
Zone 4 with *N. planulata* and *N.* (*Assilina*) cf. *nili* . .	Ypresian and Sparnacian.
Zone 3 with *N.* (*Assilina*) cf. *nili*	
Zone 2 } without nummulites	
Zone 1 }	

An important memoir by Professor Carl Diener, giving a description of the permian fossils collected in the Central Himalayas by members of the Geological Survey during 1898—1900 is in the press. The details made available tend to accentuate the distinction in facies between the normal permian rocks of the Central Himalayas and the permian blocks brought from some unknown region and left as isolated crags on the younger strata. The permian fossils in these exotic blocks show greater affinities with the Salt Range permian than with the strata of the same age in the Central Himalayas.

9. PUBLICATIONS. The following official geological papers and articles have appeared:—

General Report on the work carried on by the Geological Survey of India, from the 1st *April* 1901 *to the* 31st *March* 1902.

Memoirs, Volume xxxii, Part 3. *Notes on the "Exotic Blocks" of Malla Johar in the Bhot Mahals of Kumaon by* A. von Krafft.

Memoirs, Volume xxxiii, Part 2. *Title-page, contents, etc.*

Memoirs, Volume xxxiii, Part 3. *The Geology of Kalahandi State, Central Provinces*, by T. L. Walker.

Memoirs, Volume xxxiv, Part 2. *The Mica Deposits of India, by* Thomas H. Holland.

Memoirs, Volume xxxv, Part 1. *Geology of Western Rajputana by* Tom D. LaTouche.

Palæontologia Indica, Series XVI, Volume i. *Title-page, contents, etc.*

Palæontologia Indica, New Series, Volume ii, Article 1. *Observations sur quelques plantes fossiles des Lower Gondwanas par* R. Zeiller.

The following non-official communications were published during the year:—

(1) *On Tidal Periodicity in the earthquakes of Assam*, by R. D. Oldham; Journal of the Asiatic Society of Bengal, Vol. lxxi, Part 2.

(2) *On the Geology of Perim Island*, by Miss C. B. Raisin, Geol. Mag., Vol. ix, 1902, page 206.

(3) *The Quartzites of Delhi and Jaipur*, by J. Parkinson, Geol. Mag., Vol. ix, 1902, page 262.

(4) *Occurrence of Radiolaria in Gondwána beds near Madras*, by S. K. Coomaraswamy, Geol. Mag., Vol. ix, 1902, page 305.

(5) *On the distribution of the Glossopteris flora*, by E. A. Newell Arber, Geol. Mag., Vol. ix, 1902, page 346.

(6) *Correlation of the Devonian limestones of the Hindu Khoosh*, by Lieut.-Genl. C. A. McMahon, Geol. Mag., Vol. x, 1903, page 52.

(7) *On the constitution, origin, and dehydration of Laterite*, by T. H. Holland, Geol. Mag., Vol. x, 1903, page 59.

(8) *Ueber Hydrargillit von den Palni-Berg in Süden Indiens*, by H. Warth, Centralblatt für Min., Geol., etc., 1902, page 176.

(9) *Origin of the hanging valleys in the Himalayas*, by E. J. Garwood, Quart. Journ. Geol. Soc., Vol. lviii, page 703.

(10) *Geology and Mineral resources of Kumaon and Garhwal*, by F. J. Stephens, Trans. Inst. of Min. and Met., Vol. x, 1902, page 303.

XIII. **Applied Geology.**—1. COAL. Towards the close of the season 1901-1902, some rolled fragments of coal were found in a stream about 4 miles west of Barapani near Shillong. Following up this discovery this season the origin of the coal was traced to some outcrops situated near the headwaters of the Uru Rileng stream at the foot of Dinghie hill, about 2 miles west of the Shillong-Gauhati road. A fairly good section was laid bare; in this were several horizons of coal, the most important seams being one 4 feet and another 6 feet 6 inches thick.

Assays of two samples in the Laboratory showed the coal to be of good quality, and its position, within 11 miles of Shillong and only 2 miles from the cart road, warranted a careful exploration of the field. The work of testing the resources of the field was undertaken by the Public Works Department, with the assistance of advice from a geological officer. Two pits, put down at selected distances, reached respectively 28 and 21 feet when difficulties arose from the influx of water, and the test was continued by boring. Matters were at this inconclusive stage at the end of the year.

During January a Mining Specialist of the Geological Survey undertook the examination of the coal deposits in the Isakhel tahsil of Mianwali district, Punjab. Four groups of deposits were examined: these are (1) Kálabágh area, (2) Kuch area, (3) between Kuch and Sagruto summit, and (4) Mulla Khel and Sultan Khel area. The Kálabágh coal deposits were found to be very variable in quality and thickness of workable seams, and the estimate of about 50,000 tons of available fuel is based on the assumption that an average thickness of 4 feet would be maintained over a strike of 550 feet. At Kuch, about 6 miles further north and less favourably situated for transport to the Indus, a rough estimate was made of 11,000 tons of available coal for a seam averaging about 16 inches in thickness. The coal seams opened by drives in the ground between Kuch and the Sagruto peak are not considered to be worth working. A more promising result was obtained in the fourth area examined. From the outcrop seen in the Barochi gorge about 2 miles north of Mulla Khel, a seam varying from 1 to 4 feet in thickness was traced for about 6 miles to the south to a point west of Sultan Khel. Samples taken from this seam and from the three other areas are now being examined in the Laboratory.

2. CHROMITE. In April 1902 an officer of the Geological Survey examined the chrome iron ore deposits in the Pishin and Zhob districts. The chromite occurs as veins and irregular, segregated masses in the serpentines that accompany the great basic intrusions of upper cretaceous age which form particularly

conspicuous masses amongst the hills bordering the Upper Zhob Valley, both to the north and south. To the westward these serpentines continue into the Upper Valley of the Pishin river, which forms the geographical and geological continuation of the Upper Zhob, while to the east and north-east a few observations made at different times by various geologists indicate their continuation at intervals along the Lower Zhob and even as far as the Tochi Valley. One of the most promising localities occurs about 2 miles east of Khánozai in the Pishin district, where Mr. Vredenburg specially investigated a vein-like mass about 400 feet long with an average breadth of 5 feet; the vein consisted of almost pure ore of great richness. An analysis made in the Geological Survey Laboratory gave over 54 per cent. of chromium sesquioxide, and some parts of the vein show even a higher percentage. The locality is connected by a good road with Khanai railway station, 17 miles distant.

3. FIRE-CLAY. A fire-clay noticed in the Jaintia hills near Jowai was, at the request of the Chief Commissioner of Assam, re-examined and sampled for testing. The tests, conducted by Messrs. Burn & Co., show that the material forms excellent fire-bricks capable of standing a great heat. Its occurrence in quantity, in the neighbourhood of coal, makes it available for the manufacture of bricks; the only consideration on the other side is the cost of transport to a market.

4 GOLD. On account of the numerous statements which have been made in the past about finds of gold and of the occurrence of ancient gold-workings in Chota Nagpur, a survey of the most prominent parts of the division was instituted in the season 1901-1902 by a Geological Survey party and was continued during the past season, the party being strengthened for the purpose. The details of these investigations will be given in a special memoir.

The area examined covers parts of the districts of Manbhum and Singhbhum, with the tributary states of Gangpur, Bonai, Udepur, and Jodhpur. The geological formation known as Dharwarian, which consists of a group of imperfectly foliated schists and phillites, similar in general characters to the oldest unfossiliferous rocks distinguished as the Cuddapahs, occupies a large part of the area. A prominent and important feature in the country is the great Dulma band of dioritic trap, which runs from south of Dhadka in Manbhum into western Singhbhum, has affected all the rocks in its neighbourhood and appears to be responsible for the auriferous character of the quartz veins, as all the instances of gold found *in situ* have been in close proximity to the Dulma trap, or to dykes of a similar petrological character. The most conspicuously auriferous horizon in the Dharwar series is a little south of the Dulma trap band, just outside the zone of pronounced thermal metamorphism, and, judging by the distribution of alluvial gold at Patkum and in Mánbhúm, a similar auriferous horizon exists to the north of the trap. The well-known copper-bearing zone to the south was not specially studied, the work being confined to testing the resources of the country in gold.

Gold being of wide distribution and capable of being profitably worked in rocks carrying small quantities, it is never safe to assume from a few scattered observations that it certainly does not exist in payable quantities in any area of crystalline rocks. In the case of Chota Nagpur, without asserting that payable gold deposits do not possibly exist, the results of the present enquiry have not included a single instance which could be reasonably regarded as a legitimate mining proposition.

With regard to the quartz reefs, the deposits are thin and their mineral contents patchy; so much so that instead of expressing the richness in ounces per ton, the ore bodies are so small that they might more appropriately be expressed as grains to the ounce of quartz. The full report will show that the operations conducted by the survey party did not extend to any depth. But the common fallacy that an auriferous vein necessarily improves with depth has not been allowed to divert the party from the policy of making superficial examinations of many outcrops instead of deeply prospecting a few.

In the course of the survey, two doubtful prospecting propositions were discovered, that is, two areas where, on commercial principles, further search for auriferous veins may be regarded as a justifiable venture. These are (1) the range between Ankua and Manharpur, and (2) the line lying about 3 miles south of the Dulma trap connecting Sonsal and Sonapet. The first is men-

tioned on account of the rich coarse alluvial gold found in the immediate vicinity, of the rich specimen of auriferous quartz* picked up in the Ankua stream, and of the existence of large, well-defined quartz reefs in the neighbourhood. Along the second area nearly all of the gold hitherto found *in situ* in this division has been obtained.

The recovery of gold from alluvial deposits offers no brighter prospects than that of mining quartz veins. Hydraulic mining, as practised in other countries, is out of the question on account of lack of water and the poverty of the gold-content. At Sonapet, conditions for the storage of water on a large scale, and under sufficient head, are extremely favourable; but the result of trials indicated the average gold-content to be less than 1½ grains per cubic yard: considering the large capital outlay necessary, this amount is far too small to give any hope of profitable return. At Ankua, also, water could be obtained at no great cost, but the gold-content here is only about ½ grain to the cubic yard—even lower than that of Sonapet. It has been suggested that the richer gravels, at least, could be shifted at a profit to suitably situated tail-races by coolie labour, but, though this may be possible for dry gravel, the handling of gravel full of water would hopelessly handicap the undertaking.

The suggestion to undertake dredging operations has also been kept in view: but the conditions of the Chota Nagpur rivers introduce difficulties not usually encountered in successful dredging operations. Most of the rivers flow over the hard, upturned edges of schistose rocks, which, as in the Súbanríkha, form a succession of rocky bars across the stream, between which native workers wash for gold. Operations would necessarily be intermittent on account of the annual floods, and with each flood the layers of "wash" stripped would be covered with several feet of fresh *débris*. The layers of gravel, not more than 3 to 6 inches thick, in which the gold is stored, rarely contain more than a grain of gold to the cubic yard.

There is one possible exception to this general condemnation. In the Brahmini river, near Durjing in Bonai, the alluvial flat would, if the gold-content were sufficient, make an ideal "pond dredging" proposition; but the tests made show a content of less than one grain to the cubic yard, which would be insufficient for profitable work.

To what extent this general conclusion is justified by the observations made, the expert will be able to judge on publication of the detials; but it should be understood that the operations which have been conducted have not exhausted the *possibilities* of the area. Gold is undoubtedly widely distributed—indeed, almost universal—in the country examined, and future explorations *may* possibly reveal an instance of local concentration in payable quantities. But the results so far obtained, during a fairly conducted exploration, are sufficient to show that in the absence of such definite evidence, gold-prospecting in this area could not, except in the possible instances named, be honestly recommended as a reasonable venture.

Whilst there are not wanting evidences of the persistent search for gold in Chota Nagpur during the past, there are no signs of extensive and deep ancient workings such as are known in the auriferous tracts of South India. The general distribution of the metal evidently attracted numbers of native workers in the past, but there is no striking instance to show that their efforts were maintained for long in any one place, and this interpretation of their results is in agreement with the conclusions of the survey just made.

5. Iron and Manganese. Among the questions of economic importance taken up during the survey of the Duar forest, the rich iron ores which form fault-breccias received attention. They follow lines of faulting, the richest hematitic deposits being found along the great fault, which Blanford long ago recognized as separating the Vindhyan and Bijawar systems, throughout the entire district from east to west. The main, and at present insuperable, difficulty in connection with the development of these ores on a large scale is the absence of mineral fuel.

Manganese ores are widely distributed as a cementing material in the coarse conglomerate at the base of the Lameta series. These and some other minerals of possible value are now being analysed in the Laboratory.

6. Lead. An officer of the Geological Survey was deputed to the Dargoti State, north-east of Simla, to report on a lode of galena, regarded by the State

officials as possibly valuable. His observations, supported by the assays made, showed that the ore-body is neither rich enough nor large enough for successful exploitation.

7. PETROLEUM. An officer of the Geological Survey examined the area covered by the newly delimitated blocks extending northwards from the ground in the Pakkôko district described by the late Mr. Grimes. The absence of topographical details on the maps, already adverted to in the concluding paragraph of Section II of this report, rendered the preparation of a detailed geological map impossible, but by obtaining the positions of the boundary pillars it was possible to trace the course of the anticline running northwards from the Yenangyat oil-field.

Throughout most of its course, Prome-beds are exposed in the axis of this anticline. The first oil-sand is exposed in the Ngapokchoung in block 48; the first four in block 57 and the first five in block 67, after which, on going north, the axis pitches rapidly to the north and the exposure of Prome-beds dies out completely in block 123. The structure is that of a productive oil-field, and it is possible that a remunerative supply of oil could be obtained; but the free exposure of the upper oil-sands must have led to the escape of large quantities, and the absence of cover, owing to the exposure of the Prome-beds, will prevent the development of pressure which gives rise to the flowing wells of Yenangyat. At the same time, although the known oil-sands may be less productive than at Yenangyat, lower beds are made more accessible for exploration by the rise of the anticlinal axis, and the possibility of the occurrence of lower oil-sands may thus be tested by boring.

8. WATER. An officer of the Geological Survey examined during May certain localities in the neighbourhood of Quetta to ascertain the possibility of obtaining a supply of artesian water, and points were selected where boring tests will be undertaken by the local authorities.

During the survey of the Dhar forest attention was given to the question of water supply, as the Nemanpur pargana is unfavourably situated in this respect. Nearly the whole of the pargana is in the condition of a terrace situated at an altitude intermediate between that of the deep Narbada valley to the south and the much loftier Malwa plateau to the north. The flatness of the terrace is remarkable, and is explained by its representing an ancient cretaceous pereplain of hard Bijawar and Vindhyan rocks, once more brought to light owing to the denudation of the easily-weathered, overlying Lameta rocks. From the foot of the Malwa scarp to the edge of the cliffs that overlook the Narbada, the level of this land remains almost everywhere the same, generally a little under 900 feet. Water-courses are scarce, and develop into gorges which gradually become deeper as they approach the Narbada. In many cases the stream-beds get lost in "swallow-holes" and the whole plateau is thus drained so effectively that it is very difficult to obtain any water during the driest part of the year, notwithstanding the fairly abundant rainfall. This circumstance, together with the natural aridity of much of the Bijawar and Vindhyan outcrops, accounts for the region never having been occupied by a strictly agricultural population, and since the abandonment of the iron mines, consequent on the importation of cheaper foreign metal, the district has been practically deserted. The physical conditions are the very opposite of those required for artesian wells. Nearly all the shallow wells fed by the surface water become dry during a part of the year, while the sinking of deep wells is too costly and too uncertain to be recommended. Hence in those parts of the plateau where patches of cultivable land exist—usually in connection with Lameta outliers—all efforts should be restricted to surface works, such as the construction of dams and perhaps of small canals. These remarks do not apply to the strip of land in the northern part of the pargana, along the foot of the Malwa scarp, where water usually exists at small depth, and where the weathering of the basalt produces 'black soil' of great richness

9. CORUNDUM. The Reporter on Economic Products to the Government of India reports an application from London for this product, but at too low a price. India supplies its own lapidaries with sufficient for their needs and could export largely were rates satisfactory. But Europe is largely and cheaply supplied from the Levant, and America is supplied from the United

States; besides, in America, two abrasives, carborundum and crushed steel, are found superior to corundum. Carborundum, which is manufactured by heating sand, coke, sawdust, and salt together in an electric furnace, is now being sold in India. The Reporter on Economic Products reports also that at the instance of the Dewan of Kishengarh an attempt was made to find a market in London for Kishengarh garnets. They were, however, reported lustreless and quite inadequate rates were offered; even for abrasive purposes garnets at present find no market in London.

10. MINES. The Chief Inspector of Mines for India reports that from mines worked under the Indian Mines Act, coal mines account for nearly 90 per cent. of the mineral output; of this, mines in Bengal contribute 92 per cent. Two coal-fields in the Central Provinces and two in Upper Burma are being prospected. Mica is the mineral next to coal in importance; manganese ores are being actively worked in Madras and in the Central Provinces. From mines not working under the Act, gold is the most important product; salt comes next; clay, coal, and petroleum follow. As regards value of output, gold at 296 lakhs of rupees is most important, closely followed by coal at 219 lakhs; of the two, however, coal is the more important as regards utilization of labour, employing 64 per cent. of the total mining population against 18 per cent. on the gold-fields. The salt obtained is valued at 48 lakhs; the clay at 41 lakhs; petroleum at 32 lakhs, saltpetre at 29 lakhs; mica and manganese, each at 4 lakhs.

XIV. **Zoological Survey.**—The surgeon-naturalist attached to the Marine Survey of India continued the work of zoological collection on the Arracan coast and in the Andaman Sea. During part of the year he was provided with working accommodation in the Indian Museum.

A large collection of Indian Deep Sea *Holothuria* made by the officers of the Marine Survey engaged the attention of Professor Koehler, of Lyon, with a view to future report. In Dr. Koehler's opinion the collection ranks in importance with that made by the *Challenger*.

Important contributions to the Zoology of the Laccadives and Maldives have been published under the editorship of Mr. Stanley Gardiner, of Cambridge, as part of a detailed survey of these islands made by Mr. Gardiner himself.

While on furlough in England, Major Alcock, of the Indian Museum, continued his work on the crustacean fauna of India, being accommodated at the British Museum (Natural History). An important monograph on the *Phalangidæ* of the Indian region, based on the collections of the Indian Museum, was completed and communicated to the Linnean Society, by Dr. C. With, of Copenhagen.

Work of the highest biological and economic importance relating to the origin and formation of pearls was published by Dr. Lyster Jameson and Professor W. H. Herdman.

The official publications issued by the Trustees of the Museum include—

(1) *An account of the Hexactinellid Sponges, collected by the* R.I.M.S. "Investigator," *by* F. E. Schulze, Ph.D., M.D., Professor of Zoology in the University of Berlin.

(2) Indian Museum Notes, Vol. v, No. 3.

Officers of the Indian Museum have contributed the following non-official papers:—

(1) *On some cases of Abrupt Variation in Indian Birds, by* F. Finn; Journal of the Asiatic Society of Bengal, Vol. lxxi, Part 2.

(2) *On specimens of two Mauritius Birds in the collection of the Asiatic Society of Bengal, by* F. Finn; *ibid.*

(3) *On Hybrids between the Guinea-fowl and Common-fowl, by* F. Finn; *ibid.*

(4) *On a collection of Birds from Upper Burma, by* F. Finn (*in collaboration with* Captain H. Wood, R.E., Survey of India); *ibid.*

(5) *General notes of Variation in Birds by* F. Finn; *ibid.*

(6) *On new and little known Butterflies, mostly from the oriental region, by the late* L. de Nicéville; Journal of the Bombay Natural History Society, Vol. xiv.

(7) *The Cage Birds of Calcutta, by* F. Finn; *ibid.*

Zoological contributions relating to India by other writers published in India during the year include—

(1) *Notes on animals kept in the Alipur Zoological Garden*, I—III, *by* R. B. Sanyal; Journal of the Asiatic Society of Bengal, Vol. lxxi, Part 2.
(2) *Note on a disputed point in the life-history of* Helopeltis theivora, *by* H. H. Mann; *ibid.*
(3) *The moths of India; Supplementary paper to the volumes in the Fauna of British India:* Series II, 6, 7, *by* Sir G. F. Hampson, Bart.; Journal of the Bombay Natural History Society, Vol. xiv.
(4) *Descriptions of new genera and species of* Hymenoptera *collected by* Major C. S. Nurse at Deesa, Simla, and Ferozepore, I *and* II, *by* P. Cameron; *ibid.*
(5) *Memoirs on Oriental* Rhynchota, *by* G. W. Kirkaldy; *ibid.*
(6) *Notes on the Hog deer in Burma, by* Veterinary Captain G. H. Evans; *ibid.*
(7) *The earwigs of Ceylon, by* Malcolm Barr; *ibid.*
(8) *Aids to the differentiation of snakes, by* Captain F. Wall, I.M.S.; *ibid.*
(9) *A catalogue of the* Heterocera *of Sikkim and Bhutan*, XII, XIII, *by* G. C. Dudgeon, *with notes by* H. J. Elwes, *and additions by* Sir G. F. Hampson, Bart.; *ibid.*
(10) *The Birds of the Madhubani sub-division of the Darbhanga district, Tirhoot, with notes on species noticed elsewhere in the district*, III, IV, *by* C. M. Inglis; *ibid.*
(11) *The King Cobra or Hamdryad, by* Veterinary Captain G. H. Evans; *ibid.*
(12) *The butterflies of the Lucknow district, by* G. W. V. de Rhé-Philipe; *ibid.*
(13) *Les formicides de l'Empire des Indes et de Ceylon, par* A. Forel; *ibid.*

Contributions relating to India published elsewhere during the year include—

(1) *Fauna of British India:* Rhynchota, *by* W. L. Distant.
(2) Numerous papers on the Insect Fauna of India in the *Annals and Magazine of Natural History*, by Mr. P. Cameron, Major G. C. Nurse, and Mr. D. Sharp.
(3) A paper on the Anatomy of *Pontiothauma*—a genus of Indian Deep Sea *Mollusca*, in the *Journal of the Linnean Society*, by Mr. S. Pace.
(4) A paper on the habits of the Indian Elephant, in the *Proceedings of the Zoological Society*, by Mr. H. Slade.
(5) A paper on the habits of the Hoolok, in the *Proceedings of the Zoological Society*, by Dr. G. Candler.

XV. **Applied Zoology.**—1. Economic Entomology. Investigations have been made throughout the year, by Mr. E. P. Stebbing, on the subject of insects that injuriously affect forest trees. The issue of a series of circulars dealing with the general appearance and method of work, the natural history and habits, and the remedies against prominent insect-pests, has been initiated. An officer of the Veterinary Department was deputed during the year to investigate a plague of grass-hoppers in Central India; the practical suggestions he was able to make for the destruction of the grass-hoppers and protection of the crops are considered by the local authorities to be of great value. The attention of the Government Botanist, Madras, was given during the year to the cockchafers of the Nilgiris and to cases of the attacks of eelworms on the roots of pepper-vines in the Wynaad. Mr. H. H. Mann, of the Indian Tea Association, has cleared up certain doubtful points connected with the ravages of *Helopeltis*.

2. Breeding operations. A successful scheme for the breeding and rearing of donkey stallions on a small scale, in connection with mule-breeding operations, has been commenced by the Veterinary Department on the Government Cattle Farm at Hissar. The results seem to prove conclusively

that, with careful selection and judicious rearing, donkeys can be bred that are better, more powerful, and in every way more suited to Indian conditions, than can be purchased at three times the cost in foreign markets.

3. INSECT AND ANIMAL PRODUCTS. An endeavour is being made to ascertain how many kinds of insects producing commercial lac exist in India; information on this point is all that is now required to complete the enquiry conducted by the Reporter on Economic Products on this subject. Most of the samples of bees'-wax collected by the Reporter in 1894-95 have now been chemically examined in the laboratory, and a full report is being drawn up giving their sources, methods of manufacture, and composition. The Reporter notes that, with one exception, these samples are pure; many, however, might be cleaner, and one, owing to want of care in refining, is of dark colour.

The Reporter on Economic Products has collected information on the jerked-beef industry of Agra and the Central Provinces, on sundry animal foods of Burma, on the catgut industry of Calcutta, and on the glue industry of Lucknow, but more information is required and is being sought.

Sericultural operations have been conducted by the Inspector General of Agriculture in Kashmir and in Mysore; in the latter province a subordinate of the Agricultural Department has worked under Japanese experts.

A List of notes and references to the Indian Animal Products and Manufactures, by Sir G. Watt, has been prepared.

4. MISCELLANEOUS. The physiological action of and antidote to snake-venoms have been further investigated by Captain G. Lamb, I.M.S., who has published some of his conclusions in the Bombay Natural History Society's *Journal*.

XVI. **Veterinary Pathology and Veterinary Bacteriology.**—Doubts have been thrown on the existence of "Dourine' in India, but careful investigations by two officers of the Veterinary Department, whose researches have been corroborated by the Imperial Bacteriologist, prove that it is a prevalent disease and is a serious menace to horse-breeding operations in India. During the year, 16 Government horses and donkey stallions were found to be suffering from the disease and had to be destroyed. The measures necessary for its suppression have been adopted.

The Imperial Bacteriologist has carried out at Muktesar and Bareilly experiments on Rinderpest, Anthrax, Barbone or Hæmorrhagic Septicæmia, Hœmoglobinuria or 'Red-water' in cattle and buffaloes, Surra, Dourine, and Tubercle. A series of exhaustive experiments was carried out to test the immunity conferred by Rinderpest Bile; the results tend to show that at present the method cannot be practically applied in India. Experiments have been continued in order to determine the best and quickest method of producing a sérum of high protective value. The experiments with regard to various samples of sera deposited at Meerut, Quetta, and Muktesar are interesting and show that in order to prevent deterioration it will be necessary to adopt measures to keep the temperature as near 80° Fahr. as possible. The experimental pits which were established at Lahore and Nagpur—two of the hottest places in India—recorded a maximum temperature of 90° and 84·5° Fahr., respectively; it is therefore anticipated that there will be no difficulty in establishing at a trifling cost, in any part of India, depôts where the serum will retain its full protective power.

Cattle from the districts of Lucknow, Jalaun, Meerut, and Moradabad were experimented on with a view to ascertaining the correct dose of serum required for these breeds. The results were satisfactory and proved that the standard dose issued from the laboratory confers immunity on the breeds of cattle in these districts.

An Agricultural Ledger, Special Veterinary Series, on *Hydatids in Indian Cattle*, has been prepared.

XVII. **Botanical Survey.**—1. ASSAM. In the Brahmaputra Valley the services of a native collector were employed in collecting materials especially for a survey of the crops grown in the province. With the co-operation afforded by Major Shakespear, Superintendent of the Lushai Hills, it was possible to depute a European subordinate officer of the Royal Botanic Garden, to whose superintendence the Botanical Survey of Eastern India is entrusted, for the purpose of

making a careful collection in the Northern Lushai Hills, a region previously practically unknown botanically. The results of this deputation promise to be of extreme interest when time is available to work them out fully. Mr. J. Marten, of the Forest Survey, made during the year, in the course of his survey work, an exceedingly interesting and valuable collection of plants, several of them previously not known to exist in Assam, where his professional work lay.

2. BENGAL. In Chota Nagpur the Botanical Survey has had the benefit of effective assistance from various officers and gentlemen. F. A. Slacke, Esq., Commissioner of the Division, permitted a native collector to be attached to his party during a tour in the Tributary States, with the result that a very excellent collection was made in which are present a number of species previously not known to occur in Bengal. The Reverend Father Cardon, S.J., has also given assistance in supervising the work of native collectors entertained by the Survey in Southern Chota Nagpur; the results of these collections have been equally interesting. Still more striking have been the results of a careful investigation of the Singbhum forests by Mr. H. H. Haines, of the Forest Department; the records he has supplied of species hitherto deemed only Himalayan, or Assamese, or even Burmese are remarkable whether as regards their number or their nature.

From Orissa, one of the least adequately explored divisions of India, Mr. J. H. Lace, Conservator of Forests, Bengal, contributed a very valuable collection which has done much to demonstrate the nature of the vegetation of this area. In the Sundribuns the Director of the Survey was himself able to make a botanical tour and bring together a collection which, along with previous available material, has afforded the basis for an ecological account of the Sundribuns vegetation, a census of the plants to be found in this area, and a discussion of the dispersal and distribution of the species.

3. BOMBAY. The officer in charge of the Botanical Survey of Western India with one of his subordinates was able to make botanical tours in parts of Belgaum, Sawantvadi, and Ratnagiri; Poorandhar and Sholapur; Mahableshwar and Pertabgarh; parts of the Poona Ghats, Bhor State, Kolaba, and Thana districts. The results of these journeys have been useful in supplying material to replace the very valuable Poona Herbarium collection which was destroyed by fire and in some cases have been of great interest by supplying records of species previously unknown to occur in Bombay. Mr. G. M. Ryan, of the Forest Department, and the Superintendent, Victoria Gardens, Bombay, have also contributed many specimens replacing those that were lost and helping to restore the new Poona Herbarium to the useful and valuable condition of the one that perished.

4. BURMA AND ANDAMANS. The Curator of the Calcutta Herbarium was deputed to make an exhaustive botanical survey of the Minbu district. This district is situated in and is very typical of the dry and subdesert zone in Burma, a tract regarding which our knowledge was particularly defective. As ancillary to this investigation native collectors were sent to adjacent districts in the same zone. The results of this tour promise to be of extreme interest, since the collections made contain a large number of species hitherto quite unknown from Burma, many of them species believed to be confined to the drier parts of the Deccan, not a few of them plants hitherto supposed to be confined to Rajputana and the countries to the west of India. Much assistance was rendered to the Survey Officer during this tour by the officials of Minbu and particularly by the Superintendent of Land Records. The Conservator of Forests, Rangoon, and his subordinates, have collected a number of exceedingly interesting plants on behalf of the Survey; the extent to which they have added, from Tenasserim, records of valuable timber trees previously believed to be restricted to Malaya is remarkable. The Deputy Conservator of Forests, Port Blair, has also given assistance to the Botanical Survey.

5. MADRAS. The Government Botanist, Madras, who is in charge of the Botanical Survey of the Madras Presidency, made a short tour in the Godaveri gorges, during which he investigated the dry flora along the banks of the river and collected a number of species among the evergreen forests of the Eastern Ghats. Smaller collections were made in the Kistna district, in Coorg, around Coonoor and Ootacamund, at Gudalur, in the Wynaad, and down the Tambracherry Ghat. The collection of a fungus flora of the Presidency, for the use of the Cryptogamic Botanist to the Government of India, was commenced.

6. NORTHERN INDIA. During the early portion of the year the services of native collectors were utilized in providing materials for the completion of the *Flora of the Upper Gangetic Plain*. The chief contribution to the Botanical Survey of Northern India during the year has been a very full collection, with vernacular names and economic notes, of the plants of the Banda district, by Mrs. A. S. Bell, who may, it is hoped, ultimately prepare for publication a list of the determinations that have been effected on her behalf at Calcutta after she has completed a comparison now being made by her at Kew of her specimens with those of the late Mr. Edgeworth, I.C.S., who many years ago gave close attention to the extremely interesting flora of Banda and Bundelkhand.

7. PUBLICATIONS. The Director of the Botanical Survey has completed an enquiry into the number and characters of the species of *Dalbergia* in South-Eastern Asia. This genus is one of unusual difficulty because it is not always easy to delimit its species and because it does not lend itself readily to natural sub-division. It is, however, of great economic importance since it yields well-known timbers like the Shisham and the Bombay Blackwood of India, the Medeloa of Assam, the Tamalan, Madama, Yendike, Thitwin, Thitpoh, and other valuable timbers of Burma, the Trắc and Cam-lai of Cambodia, the Tëzu and Tán of China. From various causes there was no certainty, in treatises published prior to 1901, that any *Dalbergia* reported from a locality other than its *locus classicus* was entitled to the name applied. Having regard to the great economic importance of so many of its species, a termination of so unsatisfactory a state of affairs was desirable. The Director has besides prepared for the use of those interested in the vegetation of Bengal a list of the phanerogams, ferns, and fern-allies indigenous to or commonly cultivated in the Lower Provinces and Chittagong, with definitions of the natural orders and genera and keys to the genera and species. The Curator of the Calcutta Herbarium has similarly prepared a census of the Indian Polygonums which should, when published, prove extremely useful.

The following scientific publications have been issued during the year in connection with the Botanical Survey :—

(1) Records of the Botanical Survey, Vol. ii, No. 1. *Plants of Chutia Nagpur, by* Surgeon-Lieutenant-Colonel J. J. Wood, I.M.S., retired.

(2) Records of the Botanical Survey, Vol. ii, No. 3. *Systematic enumeration of the species of* Calamus *and* Dæmonorops, *with diagnoses of the new ones, by* O. Beccari.

(3) *Flora of the Upper Gangetic Plain*, Vol. i, Part 1, *by* J. F. Duthie.

Non-official publications or papers by officers now or formerly connected with the Survey during the year include —

(1) *Flora of the Bombay Presidency*, Vol. i, Part 3, *by* T. Cooke.

(2) *Noviciæ Indicæ*, XIX, *by* D. Prain ; Journal of the Asiatic Society of Bengal, Vol. lxxi, Part 2.

(3) *Materials for a Flora of the Malayan Peninsula*, No. 13, *by* Sir G. King ; Journal of the Asiatic Society of Bengal, Vol. lxxi, Part 2.

(4) *Descriptions of some new species of Orchideæ from North-West and Central India, by* J. F. Duthie ; *ibid.*

Papers dealing with Indian Botany, by other writers, published during the year include —

The Ferns of North-Western India, by C. W. Hope ; Part III. The general list; Journal of the Bombay Natural History Society, Vol xiv.

XVIII. Applied Botany.—1. PLANT PATHOLOGY. The services of the Government Botanist, Madras, were lent to the Government of India with the object of examining *in situ* the plants of sandalwood affected by spike-disease which threatens the existence of this tree. No trace of any parasite was found in the tissues, but the parasitic character of sandal itself, previously demonstrated by Scott, of the Royal Botanic Garden, Calcutta, was re-established. The Cryptogamic Botanist for India states that measures taken to confine the disease within its present limits have met with considerable success.

In the pepper plantations of the Southern Wynaad many of the vines appear to be dying out. The Government Botanist, Madras, has examined the plantations. A number of diseases affect the vines, but no single disease is universal. The plants are liable to cankerous growths; in some cases the roots are severely attacked by eel-worms. In certain cases a hyphal infestation pervades the vessels in the fibro-vascular bundles, though this did not appear to be connected with the relative "sickness" of the plants.

A serious disease was found by the Cryptogamic Botanist for India in ginger grown at Surat. As in the preceding case, the cause is uncertain, as both a fungus (*Pythium gracile*) and eel-worms were found invading the underground parts of the plant.

A curious group of diseases which occurs in chillies, brinjals, and some other crops, where the habit of the plant is entirely changed, so that numerous small leaves and branches are produced and no fruit is developed, has been dealt with during the year by the Cryptogamic Botanist, but with negative results, as no parasite accounting for the phenomena has yet been found.

A species of *Colletotrichum* was found in abundance on dying cholam leaves on which it appeared to be saprophytic. This is stated by the Government Botanist, Madras, to be so closely allied to the species attacking sugar-cane that the two cannot be distinguished under the microscope. This being the case, attempts to stamp out this sugar-cane disease must take into account the proximity of cholam. The Cryptogamic Botanist for India reports that sugar-canes of the Bourbon type are severely attacked by *Colletotrichum falcatum*, while indigenous canes escape; he therefore fears that attempts to grow canes of the Bourbon class in Bihar may prove unsatisfactory.

During the year the Cryptogamic Botanist for India has dealt with some 100 references of diseased plants, chiefly agricultural crops; in most cases instructions for treatment were given. Many plant diseases were also investigated locally. The more important cryptogamic diseases affecting tea were examined in Assam and methods of treatment were suggested; among the latter, spraying with Bordeaux mixture promises well in the case of 'red rust,' while 'stump rot' both in tea and in coffee is found to repay treatment and has been kept in check on several estates by the simple measures recommended.

Wilt disease in Arhar (*Cajanus indicus*) has been investigated. It is found to be nearly allied to the American 'cotton wilt' which is caused by a *Fusarium*; it is a soil-borne disease and is widely disseminated in India. No recommendations can yet be made by the Cryptogamic Botanist regarding this disease or regarding the 'ticca' disease of the ground-nut (*Arachis*) which causes much damage in Western India.

The poisonous properties often possessed by the grain of kodro (*Paspalum scrobiculatum*) have been under investigation by the Cryptogamic Botanist. In nearly all the samples examined a fungus of the genus *Endoconidium* has been found. This may be suspected to be the cause of poisoning, because the only other known member of this genus (*E. temulentum*) is one of the very microscopic fungi with poisonous properties. The physiological experiments undertaken to verify this conjecture have, however, so far given negative results.

An exhaustive investigation of the rusts and smuts of cereals and other plants has been initiated. The study of the rusts on wheat and barley has been carried on at the Cawnpore Experimental Farm by the Cryptogamic Botanist in collaboration with Mr. Hayman. The results so far have been to show, as was to be expected, that these Indian field-rusts are very numerous and that many of them are new to science. The smuts, which are also the cause of much damage to cereal crops, are in much the same position. During the year some 50 rusts and smuts have been identified, and treatment, based mainly on the experience of other countries, has been recommended.

A number of diseases in fruit and forest-trees, including the Date-palm, Mango, Deodar, Babul, Pine, and Spruce have been examined by the Cryptogamic Botanist.

The following publications dealing with Plant Pathology were issued:—

The Pests and Blights of the Tea-Plant, second edition *by* Sir G. Watt *and* H. H. Mann.

A Note on 'spike' disease in Sandal (Indian Forester, appendix series, April 1903), *by* E. J. Butler.

A short Note on Stump-rot of Coffee (Proceedings of the South Mysore Planters' Association, Annual General Meeting, 1903), *by* E. J. Butler.

2. Economic and Agricultural Botany. (*a*) *Cereals, Food-Stuffs, and Fodders.*—A tentative illustrated classification of Indian wheats drawn up by the Professor of Botany at Poona was issued by the Inspector General of Agriculture. The investigation of the varieties of Juar in India has been continued by the Reporter on Economic Products and the Professor of Botany at Poona. A list of the Yams used as food in India has been drawn up by the Reporter on Economic Products in connection with the investigation in progress by that officer and the Superintendent of the Royal Botanic Gardens, Calcutta. Selected seed of the numerous races of the principal field and garden crops of India has been generally distributed by the Inspector General of Agriculture. The Reporter on Economic Products has had a detailed investigation made of several vegetables used as pot-herbs in India with reference particularly to their feeding value. The subject of Qât, or Arab Tea, has been investigated by officers of the Botanical Survey, which department has also finally reported on the attempt to introduce *Paspalum dilatatum* into India. The introduction has been successfully effected, but the new fodder, though excellent, is not superior to many fodders already in use and does not in India sustain its Australian reputation as a fodder that will thrive in seasons of scarcity and drought. An *Agricultural Ledger* (No. 9 of 1902) by A. Ghose has been issued on the famine food, *Asphodelus tenuifolius*.

(*b*) *Gums, Resins, Rubber.*—Investigations of Indian gums by the Reporter on Economic Products have been continued and samples have been submitted to the Imperial Institute for trial and valuation. An *Agricultural Ledger* has been published giving full information regarding *Acacia* gums, and clearly classifying the kinds available in India. The gum of *Prunus eburnea*, which appears to be peculiarly suitable for purposes of confectionery manufacture, is found not to be available in sufficient quantity for trade purposes.

The resin industry was dealt with conjointly by the Forest Department and the Reporter on Economic Products, the former endeavouring to extend it in the Punjab, the latter making assays of the resin prepared in Kangra and offering recommendations for its more satisfactory preparation.

The possibility of utilizing the rubber obtained from *Chavannesia* and *Parameria* climbers has been further considered by the Forest Department, and the Mergui rubber plantations have been extended. The rubber of *Urceola elastica* sent to the Imperial Institute has proved to be a material of excellent quality which promises to be of some commercial importance; that of *Willughbeia edulis* has been definitely shown to be valueless. On behalf of the Forest Department the Agricultural Chemist has analysed and reported on 44 samples of the latex of various trees.

(*c*) *Dyes and Tans.*—An enquiry into the purity of 'kamala' dye sold in India has now been completed. A report submitted by the Imperial Institute shows that, if kamala for export were sifted through straining silk before leaving this country, much useless dust would be removed from most samples. One sample is quoted as containing 86·91 per cent. of inorganic matter evidently added as an adulterant. The report states that kamala exported from India requires a guarantee.

Important questions as to the sources and quality of the supply of indigo seed from Upper India were settled by the Curator of the Calcutta Herbarium and the Biologist to the Bihar Planters' Association who were conjointly deputed to the localities whence seed is obtained in order to investigate the subject.

Experiments on tannin extracts have been conducted by the Forest Department, and the results of a number of analyses of tanning materials have been published. Further experiments have been made in two Indian tanneries with the pods of *Cæsalpinia digyna*.

(*d*) *Drugs, Narcotics, and Poisons.*—The presence and physiological action of Colchicine in *Colchicum luteum* have been investigated; the 'beans' of certain species of *Strychnos* have been collected for investigation at the Imperial Institute.

(*e*) *Oils.*—The cotton-seed oil industry and the establishment of cotton-seed oil mills in India have been dealt with by the Inspector General of Agriculture. Among industrial oils dealt with by the Reporter on Economic Products, that of the tallow tree (*Sapium sebiferum*) has been under investigation with a view to its employment as a material for soap- and candle-making; among essential oils that of the berries of *Juniperus macropoda* has been experimented with as a possible soap-perfume. Samples of Citronella oil have been examined in order to ascertain how far imperfect or bad distillation affects the scent.

(*f*) *Fibres.*—Materials to serve as a basis for an investigation of the 'Aloe' fibres produced in India have been collected by the Reporter on Economic Products, who is, in conjunction with the Botanical Survey, conducting an enquiry into the various kinds of *Agave* and *Furcroea* which produce these. Experiments in connection with the preparation of jute have been conducted by the Agricultural Department, Bengal, and in connection with these the Reporter on Economic Products is engaged in a study of the different races cultivated. The enquiry into the sources of Indian Hemp by the Botanical Department has progressed, and, so far, it appears that the diversity in the quality of this fibre, shown by its varying in value from £8 to £20 per ton, is not due to the different classes of fibre being the product of different plants, since the seed supplied from different parts of India has proved to be always that of *Crotalaria juncea*. The probability therefore is that this variation in value depends mainly, if not wholly, on the method of preparation of the fibre.

The experimental cultivation of cottons has occupied the attention of the Agricultural Department throughout the year. In Bihar the experiments were conducted on worn out indigo lands, and the Inspector General of Agriculture supplied not only the seed, but a supervising subordinate as well as cultivators from the Surat district, bullocks and implements.

(*g*) *Miscellaneous.*—Paper-making materials from Upper Burma have been investigated by the Reporter on Economic Products and attempts made to naturalize a central Asian source of paper-making material. A collection of Indian Rattans has been brought together for submission to valuation and expert opinion in London. Collections of Indian timbers have been made by the Forest Department in connection with the revised edition of the *Manual of Indian Timbers*. The following publications dealing with Economic and Agricultural Botany have appeared:—

A Manual of Indian Timbers, new and revised edition, *by* J. S. Gamble, M.A., C.I.E., F.R.S.

A Note on Plants used for food during famines and periods of scarcity (Records of the Botanical Survey of India, Vol. ii, No. 2) *by* G. A. Gammie.

Qât or Arab Tea (Indian Planting and Gardening, Vol. xii) *by* D. Prain.

The Agricultural Ledger—

1902, No. 1. *Indian Tanning Materials.*
2. *The Indian Acacias.*
3. *The Indian Aconites.*
4. *Arsenic.*
5. *Alkalis, Alkaline Earths, etc.*
6. *The Sola-pith plant.*
7. *Asphodelus tenuifolius.*

1903, No. 1. *Principles of Tea-pruning.*

Commercial circulars have also been issued on the *Candle-nut Tree, Tung Oil, Rubber from Castilloa.*

XIX. Chemistry.—Dr. P. C. Roy, of the Education Department, has contributed to the Asiatic Society of Bengal a *Study on the constitution of Dimercurammonium salts* and a further discussion of the nature and composition of *Dimercurammonium nitrate.* The conclusion arrived at is that the so-called 'mercuroxy-ammonium' nitrate is identical with dimercurammonium nitrate, and that the formation of the 'mercuroxy' compound in the presence of strong nitric acid favours the view that dimercurammonium compounds are non-oxylic in constitution.

XX. Applied Chemistry.—The chemical work in the Laboratory of the Geological Survey has included assays of coal from the Punjab, of chromite from the Pishin district, and of gold, manganese, and lead ores. The chemical work in the Laboratory of the Indian Museum has included the examination of species of *Amarantus Polygonum* and other allied pot-herbs, of *Asphodelus tenuifolius*, several species of *Dioscorea*, *Melanogaster durissimus*, *Psophocarpus tetragonolobus*, *Colchichum luteum*, resins, wax, tans. The Agricultural Chemist made determinations of the composition and nutritive value of grains used in times of famine.

In addition to the usual examinations of samples of soils, food-stuffs, and manures, the Agricultural Chemist's Department investigated the sources and manufacture of crude saltpetre for manure and crude salt for cattle. About 200 samples of nitrous earth, crude and refined saltpetre, crude salt (sitta) and refined salt were examined. One result of these investigations is to enable Provincial Agricultural Departments to arrange for cheap supplies of good crude nitre for manure and of crude salt of suitable quality for cattle. The manurial and commercial value of Christmas Island phosphates in comparison with indigenous phosphatic minerals was determined. The most important work connected with the examination of soils consisted of the analysis of 148 samples received from the Sind-Sagar canal. These soils were found deficient in organic matter and nitrogen. They harden on the surface after drying, from the presence of iron and lime rather than of clay. Their physical defects admit of material improvement by cultivation; this the cultivators effect by adding sand as 'manure.'

D. PRAIN,

Secretary, Board of Scientific Advice.

G. I. C. P. O.—No. 633 S. B. S.A.—20-7-1904.—P. M. M.

ANNUAL REPORT

OF THE

BOARD OF SCIENTIFIC ADVICE FOR INDIA

FOR THE YEAR

1903-1904.

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OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
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ANNUAL REPORT

OF THE

BOARD OF SCIENTIFIC ADVICE FOR INDIA

FOR THE YEAR

1903-1904.

In accordance with paragraph 8 of Government of India Resolution No. 22—16-2, dated Simla, the 28th August 1902, the Board of Scientific Advice submit herewith their annual report for 1903-1904, based upon the departmental reports for that year, with the exception of that portion of the report relating to the work of the Survey of India, which is based on the report of that Department for 1902-1903 published in 1904, and certain other items embodying information of later date than the period covered by any of the other reports.

I. **Trigonometrical Survey.**—The triangulation party during 1902-1903 was employed in extending the Great Salween principal series—which emanates from the Mandalay Meridional series about the parallel of 24° Latitude—eastwards. It is intended to carry the series up to the Salween river, then southwards along the course of that river to eventually join on to the previously executed principal triangulation to the south, and thus to form a strong frontier series to support any future extension of triangulation eastwards.

II. **Topographical Survey,** 1902-1903.—1. BURMA.—In Lower Burma topographical work was carried on in the Thayetmyo, Magwe, Henzada, and Tharrawaddy districts, and consisted of the supplementary survey of detail omitted from the cadastral maps and the complete detail survey of those parts of the sheets in question which had not been touched by the cadastral operations. The supplementary survey included 2,934 square miles and the new detail survey 1,786 square miles. In Upper Burma the work consisted partly of new survey and partly of supplementary survey to fill up deficiencies in maps compiled from reductions of the cadastral sheets. It was carried on in the districts of Meiktila, Myingyan, Kyaukse, Sagaing, Pakokku, Magwe, and Minbu, and a total area of 3,336 square miles of detail survey on the 1-inch scale was completed. In the Southern Shan States survey work was done on each side of the Salween river between Latitude 20° and 21°, the detailed survey on the 1-inch scale covering an area of 2,432 square miles, with a proportionate area of triangulation executed in advance.

2. SIND.—Detailed survey was carried on in the North-Eastern portion of the division. The cultivated country was surveyed on the scale of 2 inches = mile, an area of 1,946 square miles being so mapped, while the desert area to the east was mapped on the ½ inch scale, the area thus completed being 2,164 square miles, making a total of 4,110 square miles of completed survey. The usual triangulation and traversing in advance was also carried on.

3. UNITED PROVINCES.—The full survey on the scale of 2 inches = mile of the districts of the Allahabad division was continued during the year. The stations of the traverses were carefully marked and preserved so as to be available in the event of a cadastral survey being determined on at any future time. On account of the minute area of many of the villages, it has been found necessary to publish two editions of the maps, one on the 2-inch scale showing village boundaries, and another on the 1-inch scale. The area completed during the year was 1,885 square miles.

4. PUNJAB.—Supplementary Surveys were carried over an area of 3,653 square miles in parts of Montgomery, Lahore, and Amritsar districts in order to render the maps compiled from the *patwáris* surveys available for general topographical purposes. Riverain surveys are being carried on wherever the policy of demarcating riverain boundaries once for all has been carried out. Of these riverain traverses 1,158 square miles were traversed during the season. The Simla Estate boundary survey is completed, with the exception of a few sheets held over to enable the railway to be inserted.

5. CENTRAL PROVINCES.—The survey party has been employed to a great extent in bringing out new maps of the Jubbulpore and surrounding districts. In the compilation of these maps, the forest, and the local agency cadastral surveys are being utilized as far as possible. During the season 2,834 square miles were thus mapped.

6. MILITARY.—In addition to work on the frontier, the survey on the hilly portion of Sind which was allotted to the Military Survey party has been completed and 1,499 square miles have been mapped. The cantonments of Chakrata, Meean Meer, Umballa, Mooltan, and Peshawar with their bazaars, and also the bazaars of Ferozepore were mapped, and the maps of the Khagan valley revised over an area of 1,033 square miles.

7. TOTAL OUTTURN.—The total outturn for the year of topographical survey work on various scales amounted to 22,646 square miles. This is made up as follows:—

Surveyed on 1-inch scale	12,052	square miles.
„ „ 2-inch „	9,895	„ „
„ „ 4-inch „	699	„ „

III. **Forest Survey.**—1. BOMBAY.—Surveys were carried out in the Northern, Central, and Southern circles, the survey of the last named being now complete. The triangulation of the Khandesh forests was commenced. The outturn of the year was 1,373 square miles of triangulations, 487 square miles of detail survey on the 4-inch, 240 on the 8-inch, and 6 on the 16-inch scale. Excluding Sind an area of about 4,000 square miles remains for survey.

2. MADRAS.—A survey on the 4-inch scale was continued in Kurnool, Cuddapah, and South Canara. Preliminary triangulation was carried out in the Ganjam and Godavari districts and further examination and revision continued in North Coimbatore. Altogether an area of 1,411 square miles was surveyed.

3. BURMA.—An area of 623 square miles was surveyed on the 4-inch scale in the Upper Chindwin, Thayetmyo, and Ataran districts. A large area was also triangulated and traversed in advance for next season's detail survey. Two detachments in the Irrawaddy valley, brought in an outturn of 303 square miles of 4-inch detail survey and 810 linear miles of traverse in the Bhamo, Ruby Mines, and Mandalay districts, in addition to some triangulation.

4. CENTRAL PROVINCES.—The survey of Chanda with the exception of the Charla range the survey of which has not been sanctioned was completed, the outturn being 226 square miles. The survey of the Central Provinces Forests is now complete. In all over 19,000 square miles of forest have been surveyed. In addition to the special value of those surveys to the Forest Department, they are now beginning to supply useful material for the compilation of the revised 1-inch standard maps.

5. BENGAL.—A 4-inch detail survey of the Kurseong, Darjeeling, and Kalimpong forests was commenced and 232 square miles surveyed in addition to triangulation and traversing.

6. ASSAM.—A 4-inch survey of the Garo Hills and Kamrup forests was commenced and 134 square miles surveyed in addition to traversing and triangulation. This work owing to local conditions was carried on under very great difficulties.

7. PUNJAB.—The survey of the Jubbal and Tarhoch State forests was completed. In Gujrat and Rawalpindi districts 100 square miles were surveyed on a 4-inch scale, and 173 square miles in Hazara. A surveyor was also sent to Chamba to fix the position of new boundary pillars.

8. UNITED PROVINCES.—A small detachment surveyed 100 square miles in Kumaon, Garhwal, and Naini Tal.

9. TOTAL OUTTURN.—The total outturn of Forest Surveys during the year amounted to 4,062 square miles, of which 3,816 square miles were on the 4-inch scale, 240 on the 8-inch scale, and 6 on the 16-inch scale.

IV. **Cadastral and Traverse Surveys.**—1. BURMA.—In Upper Burma in Pakokku district 606 square miles were surveyed and 455 square miles traversed, and in Shwebo district 302 square miles were traversed. In Lower Burma in Kyaukpyo district 74 square miles were surveyed and 42 square miles traversed, completing the cadastral survey of the district.

2. ASSAM.—In Kamrup, Darrang, Nowgong, Sibsagar, and Lakhimpur 129 square miles of extensions of cultivated areas and 145 square miles of tea grants were traversed.

3. BENGAL.—In the districts of Bhagulpur, Backergunge, Sonthal Parganas, Ránchi, Hazáribagh, Monghyr, Purnea, Rangpur, Midnapore, and Shahabad 6,884 square miles were traversed, 2,838 surveyed, and 2,620 square miles of record-writing completed. An area of 12 square miles has been traversed for the Calcutta Suburbs Survey, and 3 square miles surveyed in detail on the scale of 50 feet to the inch.

4. UNITED PROVINCES.—In Manipuri and Jálaun districts 195 square miles were surveyed, and in Moradabad district 140 square miles were traversed. Along the Rámganga and Dhela river 155 linear miles were traversed for future cadastral survey. The civil station of Allahabad was surveyed on the scale of 200 feet to the inch, and the following towns on the scale of 64 inches = mile, *viz.*, Háthras, Koil, Sikandra Rao, Atrauli and Kosi, the whole covering an area of about 12 square miles. In the districts of Etah, Agra, Muttra, Aligarh, Bulandshahr, and Meerut, 1,113 linear miles of first class roads were surveyed for the Public Works Department on the scale of 64 inches = mile. In Allahabad and Fatehpur districts 2,113 square miles were also traversed.

5. CENTRAL PROVINCES.—A number of small scattered areas aggregating to 619 square miles were traversed in districts Saugor, Seoni, Nimár, Chánda, Raipur, Betul, Bhandára, and Sambalpur, also 10 square miles in Jubbulpore town and cantonment.

6. MADRAS.—Near the Godávari delta an area of 131 square miles was traversed and cadastrally surveyed.

7. TOTAL OUTTURN.—In all there were traversed 10,960 square miles and cadastrally surveyed 3,844 square miles.

V. **Geographical Surveys and Reconnaissances.**—This includes surveys and reconnaissances which are executed on the $\frac{1}{2}$-inch and smaller scales. In Sind 2,164 square miles of desert country were surveyed on the $\frac{1}{2}$-inch scale, while a surveyor attached to a shooting party has brought in a reconnaissance survey of 38,000 square miles of Western Tibet.

VI. **Total outturn.**—The total outturn of detail survey during 1902-1903 was 70,797 square miles, including 38,000 square miles of reconnaissance survey. The total area triangulated is 15,223 square miles, and the total area traversed for cadastral purposes was 10,067 square miles.

VII. **Geodetic.**—1. ASTRONOMICAL LATITUDES.—The observations made in 1901 with the object of testing the correctness of Major Burrard's theory that the deflections of gravity in India—hitherto attributed to accidental and local attractions—could be classified by regions, were continued in 1902-1903. The result of those observations is that it can now be prophesied with tolerable certainty that on all Himalayan meridians the direction of gravity will be found to follow one general law. In the neighbourhood of the tropic as we move northwards its direction will change from northerly to southerly; it will then remain deflected towards the south for some hundreds of miles, and it will again become northerly as the Himalayas come into view. The substitution of this original law for the old theory of local attraction will probably exercise a profound influence on future investigations and programmes.

2. TIDAL AND LEVELLING.—Tidal observations were taken at Suez, Perim, Aden, Karachi, Porbandar, Port Albert Victor (Kathiawader), Apollo Bandar, Bombay, Prince's dock, Bombay, Madras, Kidderpore, Bassein, Rangoon, Port Blair. The levelling detachment was employed in Burma on two separate lines, Thazi to Minbu, and Sagaing to Tantabin. It completed 250 miles of double levelling including the crossing of the Irrawaddy from Magwe to Minbu. In connection with those observations two sections of the earth's crust in Upper

India have been drawn. The first shows a true section of the surface of India as determined by levelling, the second shows a section derived from pendulum observations showing the surface of India as it would be, if the underlying crust were everywhere brought to the mean density of the earth's surface. The weak point in the latter section is the insufficiency of the number of pendulum stations. A comparison of the two sections however illustrates the extent to which the Himalayas are compensated by their underlying deficiencies of matter. It also shows the relative excess of matter hidden in the crust to the south of the Ganges valley, which is doubtless the cause of the southerly deflections that prevail throughout the strip of country stretching from Calcutta to Jodhpur. From this section it is calculated that a southerly deflection of gravity of 8″ or 10″ must exist at Kalianpur, the origin of the principal triangulation, and it would follow that the mapping of India has been given always a value of latitudes too high by that amount.

3. MAGNETIC SURVEY.—During the field season 1902-1903, observations were taken at four new repeat stations in addition to visits paid to the five old ones. Comparative observations were taken at Dehra Dun, Colába and Kodaikánal observatories. Five field detachments were at work during the year, the first in the Punjab, the second in the Rajputana desert, the third and fourth in the south of India. The fifth detachment commenced very late in the season owing to paucity of instruments and observed only at 14 stations. Up to the time of submission of the Surveyor General's report observations had been taken at 370 different places in addition to the nine repeat stations. The accuracy of the work was fully up to the standard laid down and left little to be desired. The new base station at Barrackpore was completed, the instruments installed and work begun. The magnetographs for the Rangoon Observatory and the vertical force instruments for Dehra Dun, had not been received at the time of submission of the Surveyor General's report. Steps have been taken in consultation with Sir Arthur Rücker, and other magnetic experts to settle the main principles on which the final reductions of the field results are to rest.

PUBLICATIONS.—During 1902-1903, the following papers were issued by the Survey of India :—

(1) General Report on the operations of the Survey of India during 1902-1903.
(2) On the projection for a map of India and adjacent countries on the scale of 1 : 1,000,000 by Colonel St. G. C. Gore, R.E. (second Edition).
(3) Spirit Levelled Heights No. 10, Madras Presidency, Central Provinces, Central India Agency, and the United Provinces of Agra and Oudh.
(4) Spirit Levelled Heights No. 1, Assam.
(5) Spirit Levelled Heights Bengal and Assam.

The following were printed for the use of the Department :—

(6) Notes on the Theory of Error of observations by J. Eccles, M.A.
(7) On the Projection used for the General map of India.

VIII. **Marine Survey.**—In the beginning of the year the survey of the Naaf river was completed. The Government mooring ground at Bombay was resounded on a scale of 12 inches to the nautical mile. On the passage of the R.I.M.S. "Nancowry" to Akyab, Commander Sinclair attempted to observe the bore of the Megna river, but owing to the loss of an anchor and the breaking adrift of the vessel, his observations were much interfered with. Commander Sinclair remarks on the phenomenon thus :—"At 0-45 P.M. on the 23rd November the bore was observed approaching about one mile distant, extending right across the river, the wave on the shoal flats being 3 to 4 feet high and in the deep water somewhat less, only occasionally breaking. As the wave approached, the ebb tide rushed towards it, increasing in velocity and altering its direction until within 200 or 300 yards from the wave, where it was running at right angles to it, forming strong eddies, until the wave struck and passed the vessel, when the flood tide set strongly at an estimated rate of 5 to 6 knots. This was also the estimated speed of the wave. Owing to the loss of an anchor it was impossible to get the speed of the wave accurately, and as a shoal bank was in close proximity to leeward of the flood, it was also

impossible to obtain it by drift. Being three days after new moon a heavy bore was expected, so that it would appear from the moderate wave experienced the bore in Shabazpur river is small as compared with that experienced at the head of the Sundeep Channel and over the flats of "Nowcolly." A survey of the approaches to Hinze Basin was made, and the existence of a narrow deep-water channel 150 yards broad discovered, which could be made use of if properly buoyed. A least depth of 15 feet at low water spring tides would then be carried right into the basin, whilst over the knolls depths of 6 to 8 feet at low water springs would have to be crossed. The rocky formation of the entrance points, encourages the supposition that little change takes place from year to year. The large rise and fall of tide, about 15 feet at Springs and 9 feet at Neaps, would enable ships of fairly deep draught to enter the basin if required. The basin, however, is much smaller than supposed, being formed of three large creeks uniting at the entrance where there is good and fairly extensive anchoring ground. The inside of the Basin is fringed with mangrove swamps. The range of the tide is peculiar, one foot more being found inside than at the entrance of the basin at spring tides. The survey of the Arakan coast was continued and that portion between Asirgarh shoal and the south point of Western Boronga was completed and sounded off to a distance of 25 miles. During the year the re-survey of the port of Akyab was commenced on a scale of 3 inches to the nautical mile, except the anchorages off the town, which will be on 6 inches. During the survey a small mud volcano was discovered in the middle of Research Strait, due east of the southern end of Western Boronga. The volcano consists of three vents forming an equilateral triangle, of which only the apical vent was discharging mud and gas at irregular intervals of from 15 to 60 seconds. The gas is probably marsh gas.

IX. **Astronomical Work.**—KODAIKANAL AND MADRAS OBSERVATORIES.—The chief instruments here are the two 6-inch refractors, a photoheliograph, a 6-inch transit instrument and an 11-inch polar siderostat used in conjunction with a 6-inch Grubb lens and a 4-inch concave grating. A spectroheliograph has been made by the Cambridge Scientific Instrument Company and the building to receive it has been nearly completed during the year. The transit building has been finished and the instrument is now in use. Regular observations have been made during the latter part of the year of widened lines in the spectra of sunspots; solar prominences and the chromosphere have also been examined and the records included in the Monthly Weather Review.

In addition to astronomical work, meteorological records, both from eye observations and self-registering instruments are obtained, and a Milne seismograph is in continuous action.

Kodaikanal is one of the base stations of the magnetic survey of India and complete registers are made both visually and by a Watson magnetograph recording horizontal intensity and declination.

At the Madras Observatory astronomical work is confined to the determination of time for transmission over India and to the port; regular meteorological observations are also made. During the year a harmonic analysis of pressure observations at Bangalore and Madras has been effected and a discussion of the underground temperatures at five different Indian stations.

BOMBAY (COLABA) AND ALIBAG OBSERVATORIES.—The Bombay observatory contains a full equipment of meteorological instruments (visual and autographic), of seismographs (for vertical and horizontal movements) and of magnetic instruments: these have been in regular use throughout the year.

In consequence of the approaching institution in Bombay of electric tramways it has been necessary to remove the magnetic instruments away from the disturbing influences and new buildings have been erected at Alibag for their reception. A set of new instruments has been installed at Alibag and a comparison of the new and old sites was begun early in March 1904.

At Dehra Dun the usual solar physics work was carried on with satisfactory results.

X. **Meteorology.**—1. OBSERVATORIES.—The observatories maintained by the Government of India are of four classes. The first class observatories

are furnished with autographic instruments for continuous records of meteorological conditions; second class observatories are those at which observations are taken daily at 8, 10, and 16 hours, and the 8 hours observations are transmitted by telegraph to Simla, Calcutta, Bombay or Madras; third class observatories include (*a*) those stations where there are telegraph offices and where observations are taken daily at 8 hours only and transmitted by telegraph like the last; (*b*) stations where there are no telegraph offices but where observations are recorded at 10 and 16 hours only, either for inclusion in the monthly weather report, or to furnish data for the determination of monthly and daily means comparable with the means determined for second class stations. Fourth class observatories record temperature, wind direction and rainfall only. At the commencement of the year 240 observatories were in use, of which 50 were non-departmental and 190 maintained by the Government of India. At the end of the year there were 49 non-departmental and 193 maintained by the Government of India. Of the latter 7 were first class, 41 second class, and 145 third class. During the year observatories provided with daily barographs and thermographs were opened at Sarain and Kalabagh on the Chor Peak, and third class observatories opened at Pendra Road, Laheria Sarai, and Myitkyina.

The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountains for the cold weather of 1903-1904 was fairly complete. The registration of rainfall has been carried out by 2,523 rain gauge stations distributed throughout India on the uniform system introduced by the Government of India in 1889 and described in the Administration Report of the Meteorological Department for 1889-90. The work of rainfall registration is steadily improving and is now satisfactorily carried out over nearly the whole Empire.

Storm warnings.—Ports on the Bay of Bengal are warned of the approach of cyclonic storms by the Calcutta office, while ports on the western side of India receive their warnings from the Simla office. The present system of storm signals which has been in operation since 1898 includes (*a*) an extended system of storm signals for use at the larger ports, (*b*) a brief system of signals for use at the smaller ports and for the benefit of country vessels. At Calcutta there are also special arrangements for supplying the latest weather information to outward bound shipping when passing Saugor island at the mouth of the Hooghly, and for obtaining early information of the weather at the head of the Bay of Bengal from vessels entering the Hooghly. The information thus given or received is occasionally of very great value to shipping. During the year storm signals were hoisted for thirteen storms affecting ports on the Bay of Bengal, while four storms visited the Arabian Sea: ample warning was given in the case of all the more important storms which visited the Indian coasts.

Flood warnings and weather forecasts.—These are issued, chiefly by the Simla Meteorological Office, to officers in certain districts liable to sudden flooding from heavy rainfall or to officers in charge of operation which may require modification according to the probable kind of weather predicted. Telegraphic warnings of heavy rain likely to give rise to serious floods in the Nerbudda, Tapti, Sabarmati or Mahi rivers are sent to twelve officers in the districts concerned. At the end of the year 67 officers in the Irrigation, Railway, and Public Works Departments required warnings. The number of special warning messages sent during the year was 847 as compared with 759 in the previous year. As regards the efficacy of those warnings, opinions were received from 45 officers, of whom forty stated that the warnings they had received were timely and satisfactory. Although every effort is made to improve the flood warning telegrams, it is still very difficult to forecast the occurrence of heavy rain in many parts of India more than 12 to 24 hours before its occurrence.

The forecasts of the probable character of the south-west monsoon and cold weather precipitation of 1903 were issued as memoranda in accordance with the instructions of the Government of India. The forecasts generally were correct, and there was only one case of complete error in the estimates of provincial rainfall contained in the monsoon forecast. About 518 sets of observations of thunderstorms, hailstorms and duststorms were sent on by

80 observers during the year, and in addition a large number of special observations chiefly in connection with storm and flood warning were received.

Seismography.—Observations were recorded for the Seismological Committee of the British Association by means of Milne's self-registering seismograph at Alipore (Calcutta), Colaba (Bombay), and Kodaikánal.

Marine Meteorology and Extra Indian Observations.—Meteorological data were as usual collected from vessels entering the ports of Calcutta and Bombay, the readings of the ships' barometers being carefully corrected. At Calcutta 1,299 logs were extracted and 4,398 barometric comparisons made; at Bombay 942 logs were extracted and 3,665 barometric comparisons made. The issue of Pilot charts giving month by month the normal meteorological conditions over the Indian seas and the Indian Ocean as far south as Lat. 12° S. was continued. Observations recorded during the year on board the Light ships at the entrance of the Hooghly were supplied to the Meteorological Department. Daily weather telegrams from Aden are sent by the Eastern Telegraph Company to Bombay and thence forwarded to Simla. The Observatories at Jask, Teheran, Muscat, and Ispahan furnished valuable information as to the approach of cold weather storms from Persia. During the south-west monsoon weekly telegrams giving useful data concerning the weather conditions in the Indian Ocean were received from Mauritius, Zanzibar, and Seychelles. Very important information as to the meteorological conditions in Africa antecedent to the south-west monsoon was received from Cape Colony, Cairo, and Zomba in British Central Africa.

Publications.—During the year the India Meteorological Office published :—

(1) India Daily Weather Report and Chart.
(2) India Weekly Weather Report.
(3) India Monthly Weather Review.
(4) Annual Summary for 1902.

The following provincial reports were issued by the Provincial Reporters during the year :—

(1) By the Bengal Reporter :—

(*a*) Bay of Bengal Daily Weather Report and Chart issued during April November and December 1903, and January to March 1904.
(*b*) Bengal Daily Weather Report and Chart issued during the period May to October 1903.
(*c*) Monthly Rainfall Table for Bengal and Meteorological Table for Bengal and Assam, with a Summary of the chief features of the weather of the month published in the *Calcutta Gazette.*
(*d*) Report on the meteorology of Bengal for the monsoon season of 1903, illustrated with rainfall maps.
(*e*) Charts showing the distribution of actual rainfall, the departure from the normal and the percentage departure were prepared monthly during the period May to October 1903, and submitted to the Government of Bengal and the Sanitary Commissioner, Bengal.

(2) By the Bombay Reporter : —

(*a*) Bombay Daily Weather Report and Chart.
(*b*) Monthly abstracts of meteorological observations published in the *Bombay Government Gazette.*

(3) By the Madras Reporter :—

(*a*) Madras Daily Weather Report and Chart.
(*b*) Monthly Rainfall Table for Madras, Coorg, Pudukota, Cochin, and Travancore published in the Provincial *Gazette.*

(4) By the Meteorological Reporter to the Government of the United Provinces of Agra and Oudh :—

(*a*) Monthly Weather Summary of the Provinces published in the Provincial *Gazette.*
(*b*) Brief sketch of the meteorology of the Provinces for the year 1902-1903.
(*c*) Monthly Rainfall Table for the United Provinces of Agra and Oudh, published in the Provincial *Gazette.*

(5) By the Meteorological Reporter for the Punjab :—

(*a*) Monthly Summary of the weather of the Punjab, published in the Provincial *Gazette.*
(*b*) Annual Meteorological Summary of the Punjab for the year 1902-1903.

The following special publications were issued during the year :—

(1) Summary and a brief discussion of observations of the clouds recorded at six stations in India, during the period 1895—1900, by Sir John Elliot, M.A., F.R.S., K.C.I.E., (late) Meteorological Reporter to the Government of India and Director General of Indian Observatories. (Indian Meteorological Memoirs, Volume XV, Part I.)

(2) Report on cloud observations and measurements at Simla during the period June 1900 to January 1902, by W. L. Dallas, Esq., Scientific Assistant to the Meteorological Reporter to the Government of India. (Indian Meteorological Memoirs, Volume XV, Part II.)

(3) Monthly normals of air pressure reduced to 32° F. and constant gravity, Lat. 45°, by Sir John Elliot, M.A., F.R.S., K.C.I.E., (late) Meteorological Reporter to the Government of India and Director General of Indian Observatories. (Indian Meteorological Memoirs, Volume XVI, Part I.)

Extra-Indian papers on the meteorology of the Indian monsoon area published during 1903-1904 include :—

The Climate of Australasia in reference to its control by the Southern Ocean, by J. W. Gregory. *Whitcombe & Tombs, Melbourne.*

The Solar and Meteorological Cycle of Thirty-five Years, by W. J. S. Lockyer. *'Nature', May 7, 1903.*

"Brief Discussion of Cloud observations recorded at six stations in India," by W. J. S. Lockyer. *'Nature,' December 24, 1903.*

XI. **Geology.**—The Geological Survey Department has continued the work of mapping previously unsurveyed areas in the Northern Shan States and the Vizagapatam hill tracts, whilst special petrological, paleontological and economic investigations have been made in other areas.

Amongst the results of a petrological kind obtained, the discovery near Kishengarh in Rajputana of a new occurrence of the remarkable family of nepheline-syenites deserves special mention. This new occurrence is remarkable for the presence of cancrinite and of a peculiar form of the mineral sodalite, which shows the unique property of rapidly changing from a pink to a grey colour when exposed to day light, recovering its pink colour after being kept for some months in the dark (*Records, G. S. I.*, XXXI, 43).

A more complete description of the sapphirine-bearing rock of the Vizagapatam hill tracts, referred to in the Annual Report for 1902-1903, has been made and published (*Records, G. S. I.*, XXXI, 38).

A number of interesting minerals hitherto unknown in India have been identified during the survey of the manganese-ore deposits. These include dialogite, spessartite, manganhedenbergite and piedmontite, in addition to a new species of manganese-pyroxine in the Nagpur District, and a new manganese amphibole in the Jhabua State, Central India (*Records, G. S. I.*, XXXI, 235).

The results of special paleontological and statigraphical interest include the discovery of remains of a remarkably large extinct species of elephant (*E. namadicus*) associated with bones of *Hippopotamus*, in the ancient alluvium of the Upper Godavari valley, Nasik District, and of other pleistocene fauna in the Gangetic alluvium about 120 feet below the surface near Allahabad. The fossils include teeth of *Bos namadicus*, with bones of *Elaphas*, *Hippopotamus*, *Bos*, *Bubalus* and *Cervus* (*Records, G. S. I.*, Vol. XXXI, 176).

It is interesting to record that, besides these discoveries in connection with the older alluvial deposits inland, a shell bed of marine origin has been found in Calcutta, raised well above the highest tide level. It appears, from this find, that the general depression, which has been going on in the Ganges delta, has been interrupted by oscillations in the relative level of sea and land.

The question of the age of the coal-bearing rocks of the Gondwana system was discussed in the Annual Report for 1902-1903 with reference to the discovery in Kashmir of typical Gondwana plants, apparently underlying, and therefore older than, marine fossiliferous rocks of undoubted Permian age. It

has since been ascertained that the stratigraphical evidence as to the superposition of the Gondwana plant bearing beds and the marine Permian strata had not been carefully criticised by the original observer, but there are fair reasons for assuming that the positive assertion with regard to conformable superposition is at any rate probably correct, and a critical examination of the fossils by Mr. A. C. Seward, F.R.S., and Dr. Smith Woodward, F.R.S., leaves no doubt as to the Paleozoic age of the Gondwana beds. The fossil plants include a new species of the Typical Lower Gondwana genus *Gangamopteris*, whilst the vertebrate remains include the Palæoniscid fish *Amblypterus*, which occurs in the Lower Permian rocks of Europe and fragments of a Labyrinthodont, *Archegosaurus*, hitherto found only in Lower Permian rocks (Pal. Indica, New Series, Vol. II, Memoir No. 2.)

This discovery of Gondwana rocks in association with marine strata in Kashmir has been followed by two other discoveries of no less scientific value. In Assam, at the other end of the Himalayan range, numerous Permo-Carboniferous marine fossils, including *Productus*, *Diclasma*, *Spirifer*, etc., have been found in boulders in the Subansiri river, and it seems unlikely that they could have travelled far from the beds from which they were derived (*Records, G.S.I.*, XXXI, 186). As the ordinary coal-bearing fluviatile Gondwana rocks are not far off from this point in Assam, it appears that we have discovered the approximate localities of two points on the northern coast line of the great Gondwana continent on which flourished the jungles whose relics are preserved in the coal beds of India.

It is known that portions of the Gondwana strata, for instance in the Darjeeling district, were involved in the earth-movements which formed the Himalayan range, but it appears likely that, though the main orographical movements have occurred since Gondwana (Permo-Carboniferous) times, there must have been a high-level barrier aligned along the present Himalayan belt right through the Paleozoic and Mesozoic eras. The observations recently made by the Geological Survey officer accompanying the Tibetan Mission showed that, to the north of the great central crystalline axis, which rises as a line of snowy peaks throughout the whole length of the Himalayan range, there is, in Eastern Tibet, a basin of marine fossiliferous rocks, forming a continuation of those previously well known, and in a corresponding position on the northern flanks of the central crystalline zone in Spiti and Kumaon. It appears that the Himalayan belt was thus approximately the southern coast-line of the great ocean which covered Central Eurasia from Paleozoic to Tertiary times.

The work of more direct economic bearing accomplished by the Geological Survey Department includes investigations of the sites selected for the large dam-reservoirs proposed to be made in connection with the extension of irrigation works in the Penner valley, Nellore district, in the Kaimur range, Mirzapur district, and near Hospet in the Tungabhadra valley. A report has also been made on the stability of certain hill-slopes in the station of Dharmsala, Kangra district.

A considerable addition has been made to our knowledge of the occurrence and characters of the chief ornamental building stones and slate in India.

Special reports have been made on the known coal deposits of the Mianwali district, Punjab (*Records, G.S.I.*, XXXI, 9), of Jammu (*Memoirs, G.S.I.*, XXXII, Part 4), and of Um Rileng north of Shillong (*Records, G.S.I.*, XXXI, 35).

The occurrence of gold in the river-gravels of North-East Assam has been made the subject of a special study (*Records, G. S. I.*, XXXI, 205), and a detailed survey has been made of the manganese-ore deposits, which have been worked so largely during the past six years in the Central Provinces. One of the most important results obtained during the year has been the definite determination of the highly aluminous character of many of the laterite deposits, some of which appear to be typical bauxites of the kind being used largely in Europe and America as a source of aluminium.

A special investigation has been made into the present state of the Sambhar salt lake in Rajputana, with a view to determining the origin and extent of the salt supplies. It has been ascertained that the salt is stored in a body of alluvial mud and sand forming the bed of the Lake, and that it has originated

in the way characteristic of salt lakes in regions of internal drainage. In addition to the sodium chloride, the sulphate and carbonate of soda occur in smaller quantities, and these, on account of their lower solubility, interfere with the manufacture of pure salt when the ratio of chloride to other soda salts approaches 65 : 35.

The depth of the mass of silt on which the lake rests has been determined by three calyx-drill borings to be about 70—75 feet in the centre of the depression, and the composition of the material forming the upper layers has been determined by analyses of about 200 boring cores taken at depths of 4, 8 and 12 feet at various localities in the Lake. The results of the investigation show that, whilst there is still a quantity of salt sufficient to supply the present mode of manufacture for many years to come, the annual removal of about 122,000 tons of the chloride, and the rejection of large quantities of sulphate and carbonate, have seriously affected the purity of the salt supplies in the upper layers of silt from which the material is beached out to form the lake brine.

The publications of the Geological Survey comprised, besides the Director's General Report for the year 1902-1903, the following papers issued either as separate *Memoirs* or in the periodical *Records* :—

Published as *Memoirs, Geological Survey of India.*

Report on the Jammu Coal-field, by R. R. Simpson, forming Part 4 of Volume XXXII.

The Seismic Phenomena in British India and their connection with its Geology, by Count F. DeMontessus de Ballore, forming Part 3 of Volume XXXV.

The Geology of Spiti, by H. H. Hayden, forming Part I, Volume XXXVI.

The sand hills of Clifton near Karachi, by R. D. Oldham, forming Part 3, Volume XXXIV.

Aftershocks of the Great Earthquake of 12th June 1897, by R. D. Oldham, forming Part 2 of Volume XXXV.

Published in *Palæontologia Indica.*

The Jurassic Fauna of the Central Himalayas, by V. Uhlig, forming Volume IV of Series XV.

The Permian fossils of the Central Himalayas, by C. Diener, forming Volume I, Part 5, of Series XV.

The Jurassic Lamellibranchiata of Cutch, by F. L. Kitchin, forming Volume III, Part 2, of Series IX.

Published in *Records, Geological Survey of India,* Vol. XXXI.

On a deposit of copper ore near Komai, Darjiling District, by H. H. Hayden.

Note on the Zewan beds in the Vihi District, Kashmir, by R. D. Oldham.

Report on the coal deposits of Isa Khel, Mianwali District, Punjab, by R. R. Simpson, (with Plates 1 and 2).

Report on the Um-Rileng coal beds, Assam, by P. N. Bose, (with Plate 3).

Note on a sapphirine bearing rock from the Vizagapatam District, by C. S. Middlemiss, (with Plate 4).

Obituary notice of Lieutenant-General C. A. McMahon, F.R.S., by T. H. Holland.

Note on Cyclolobus Haydeni, by Professor C. Diener.

The Auriferous occurrences of Chota Nagpur, by J. M. Maclaren.

On the feasibility of introducing modern methods of coke-making, by T. H. Ward.

The Upper Palæozoic formations of Eurasia, by Th. Tschernyschew.

Note on the Glaciation and History of the Sind Valley, by R. D. Oldham.

On the occurrence of a Species of *Halorites* in the Trias of Baluchistan, by E. Vredenburg.

Notes on the Geology and Mineral Resources of Mayurbhanj, by P. N. Bose.

The Geology of Upper Assam, by J. Malcolm Maclaren.

The Auriferous occurrences of Assam, by J. Malcolm Maclaren.

On a curious occurrence of Scapolite from the Madras Presidency, by E. Vredenburg.

Miscellaneous notes, including notes on—

Tin-ore and Gadolinite in Palanpur. Tin-ore in Burma. Elæolite and Sodalite-Syenites in Kishengarh. Gem-sands from Ceylon and Burma. Prehnite in Las Bela. Cretaceous fossils from Persia. Ancient Kitchen-midden in the Andamans. The supposed locality "Sulgranus". Fossil bones in the Godavari alluvium. Fossils from the Yenangyoung oil field, Burma. Assays of Raniganj coals. Titaniferous iron-ore smelted in native furnaces. Discovery of Thenardite at Didwana. Discovery of Cancrinite in Kishengarh. Pyrrhotite from the Kirána Hills, Punjab. Vivianite in the alluvium of Bengal. Recent or sub-recent marine bed in Calcutta. Pleistocene fossils from the Ganges Alluvium. A new form of amphibole from Central India. An unusual occurrence of common salt. Assays of coal and coke from Jherria and Raniganj.

XII. **Zoological Survey.**—The investigation of the marine fauna was continued by the officers of the Marine Survey, who made collections of shallow-water life in the Gulf of Martaban, and of deep-sea life in the Bay of Bengal and Arabian Sea. During the recess of the Survey the Naturalist worked as usual in the Indian Museum, and prepared a detailed report upon the sub-littoral Crustacea.

A taxidermist from the Indian Museum has been with Colonel A. H. McMahon, C.S.I., C.I.E., in Seistan, and has collected something of the interesting, if meagre, fauna of that region.

A zoological collection was made by the officers of the Tibetan Mission, but has been sent by them to the British Museum direct.

At the instance of, and with the kind co-operation of, Colonel D. Wilkie, I.M.S., the Administrative Medical Officer in Assam, arrangements have been made for collecting the dipterous insects of that province through the agency of the Civil Surgeons. The collections received will be roughly sorted at the Indian Museum and will then be submitted to specialists in Europe and America for determination.

From the zoological collections preserved in the Indian Museum certain groups have been sent to Europe to be worked out: they include Marine Mollusca, Insects, and Echinoderms.

Of large serial reports upon the fauna of this zoological region, the following have appeared:—

(1) In the Fauna of British India Series—*Rhynchota*, Volume II, Part 2, by W. L. Distant.

(2) In Mr. Stanley Gardiner's Fauna and Geography of the Maldive and Laccadive Archipelagoes, systematic papers, by various authors, upon *Hydromedusae*, *Alcyonaria*, *Madreporaria*, *Enteropneusta*, *Polychaeta*, *Marine Crustacea* and *Marine Mollusca*.

(3) Dr. Herdman's *Reports on the Pearl Oyster Fisheries and Marine Biology of Ceylon*. Dr. Herdman and his Assistant, Mr. Hornell, have succeeded in tracing the complicated life-history of the Cestode parasite to which the formation of pearls is chiefly attributable.

Of similar comprehensive reports, the following have been sent to press:—

(1) *On the Deep-Sea Holothuriodea*, by Prof. R. Koehler.

(2) *On the Paguridea*, by Major A. Alcock.

Numerous papers on Indian Zoology have appeared in various scientific serials during the year. The following are among the more important:—

(1) *On the Moths of India*, by Sir. G. F. Hampson. Journal of the Bombay Natural History Society.

(2) *On the Moths of Sikkim and Bhutan*, by G. C. Dudgeon. Journal of the Bombay Natural History Society.

(3) A series of papers on *Hymenoptera from northern parts of India*, by P. E. Cameron. Transactions of the Entomological Society, and Annals and Magazine of Natural History.

(4) *On new species of Indian Apidae*, by G. C. Nurse. Journal of the Bombay Natural History Society.

(5) *On the life-history of Gongylus gongylodes*, by Captain C. E. Williams, I.M.S. Transactions of the Entomological Society.

(6) *On a new Termite*, by J. Desneux. Journal of the Bombay Natural History Society.

(7) *On the Anopheles of Karwar*, by Dr. H. Cogill. Journal of the Bombay Natural History Society.

(8) *On a new Scale-insect*, by E. P. Stebbing. Journal of the Linnean Society.

(9) *On Polychaeta from the Maldives*, by S. Crossland. Proceedings of the Zoological Society.

(10) *On Mollusca from the Bay of Bengal and Arabian Sea*, by E. A. Smith. Annals and Magazine of Natural History.

(11) *On the Batrachians of Travancore*, by H. S. Ferguson. Journal of the Bombay Natural History Society.

(12) *On a new Apodous Amphibian*, by A. Alcock. Annals and Magazine of Natural History.

(13) *On the anatomy of the Hamadryad*, by F. E. Beddard. Proceedings of the Zoological Society.

(14) *Various papers on Birds*, by Colonel C. T. Bingham in the Ibis; by E. W. Oates in the Annals and Magazine of Natural History; and by H. S. Ferguson and C. M. Inglis in the Journal of the Bombay Natural History Society.

(15) Two papers *on new Cetaceans* from Southern India, by H. S. Ferguson and R. Lydekker. Journal of the Bombay Natural History Society.

(16) *On the brain of Nycticebus tardigradus*, by F. E. Beddard. Proceedings of the Zoological Society.

In the Proceedings and Transactions of the Royal Society several papers have been published upon the venom of Indian snakes, the various authors being Sir Lauder Brunton, Sir Joseph Fayrer, Sir Thomas Fraser, Major R. H. Elliot, I.M.S., and Captain L. Rogers, I.M.S.

During the year the Entomologist to the Government of India toured chiefly in the Bombay Presidency but also in Mysore, Coorg, and the Nilgiris to study local conditions and crops. From various parts of India 193 specimens of insect pests were received, of which 117 were miscellaneous, and the remainder locusts or specimens connected with the locust investigation. Where possible the specimens were named or information concerning them was sent out. The number of insect pests studied during the year is 67, and a further number of 52 beneficial or other insects have been studied in addition to those only sent in and not studied in the field. The pests of cotton, cane, juari, and other field crops of Western India have formed the chief part of this work. The coffee pests of South India were specially investigated. The occurrence of large swarms of Bombay locusts compelled an enquiry over western and central India. When possible, trials of remedies have been experimentally carried out. This includes testing simple remedies, preparing and using insecticides, devising methods of applying them and testing the apparatus necessary for the purpose. The application of insecticides on coffee and tea has been shown to be practicable and useful and an attempt is being made to bring this within the reach of the cultivator. The general study of the insect Fauna of India has been commenced, and a valuable collection of some six thousand specimens has been gathered during the year.

The publications of the year include:—

(1) *A bulletin on coffee pests of South India*, issued from the office of the Government Entomologist, and circulated to planters.

(2) *Circulars on insect pests*, published through the Department of Land Records and Agriculture.

(3) A paper *On the present position of Economic Entomology in India*, by H. M. Lefroy. Journ. Bombay Natural History Society.

(4) On *Notorious Insect pests*, by R. S. Hole. Journal of the Bombay Natural History Society.

(5) Three papers on *Insects destructive to Trees*, by E. P. Stebbing. Journal of the Asiatic Society of Bengal.

XIII. Veterinary Science.—1. BREEDING OPERATIONS.—The usual operations of horse and mule breeding were continued during the year by the Civil Veterinary Department. As regards the relative success of different classes of stallions as sires, the produce of Australian sires heads the list of Government prizes given at Horse fairs and shows during the year. The scheme for the breeding and rearing of donkey stallions on the Government cattle farm at Hissar in the Punjab, is now in working order and is unquestionably a thorough success. During the year four Zebra stallions were received from Africa, forty pony and donkey mares have been purchased to mate with those animals and a series of experiments in zebrule breeding will be carried out. The usual cattle breeding operations were carried out during the year by the department. Measures for giving effect to a scheme for establishing bull breeding and rearing farms have been adopted by the Governments of the Punjab, United Provinces, Central Provinces, Bengal and Bombay. A Veterinary College has been started during the year at Vepery (Madras). This College when completed should be one of the best equipped in India.

2. VETERINARY PATHOLOGY.—In the laboratory at Muktesar the preparation and issue of Anti-rinderpest, Anthrax and Mallein sera were carried out. During the year for the first time a dry Anti-rinderpest serum was prepared, which has many advantages over the liquid and is being thoroughly tested in the field. During the year 520,925 c.c. of Anti-rinderpest serum were prepared and 571,740 c.c. or 114,798 doses were issued,—a great increase on the amount for last year; 40,018 c.c. or 8,003 doses of Anthrax serum were prepared, more than double the preceding year's output; and 247 doses of English and 28 doses of French Mallein were issued, and 850 doses of Mallein prepared. At Bareilly observations on 'Dourine' cases and Camel 'Surra' were carried out, while experiments were also performed with a view to find out periods during which hill bulls are found to be protected against rinderpest when injected with varying doses of Anti-rinderpest serum and subsequently tested with virulent rinderpest material. During the year 390 outbreaks of Rinderpest were dealt with and 47,360 cattle immunised, with a mortality after injection of only 280. Forty-eight outbreaks of Anthrax were dealt with and 6,385 animals immunised with an injection mortality of 33. No opposition whatever was shown by native owners of cattle to the system of injection, which augurs well for future efforts in coping with outbreaks of cattle disease.

XIV. Botanical Survey.—EASTERN INDIA.—The most interesting tract on the eastern side of India explored during the year is Independent Sikkim and Tibet. The Director of the Botanical Survey visited the Tibet Mission and brought back a most interesting collection. In addition, large collections of plants collected between Sikkim and Lhassa have been sent down by officers attached to the Mission, and by native collectors. The botanical results, which promise to be of surpassing interest, are being worked out by the Director of the Botanical Survey. The Curator of the Calcutta Herbarium was deputed to make a botanical tour in the district of Cachar in Assam, the results of which have still to be worked out. In the Henzada and adjoining districts of Burma use was made of the agency of native collectors, while the Forest Department sent a number of interesting specimens from Tenasserim.

WESTERN INDIA.—In the course of the year the officer in charge of this Survey explored along the Poona Ghâts, over part of the Thana District around the Kanhin caves, and on the hills near Matheran. During the cold weather he investigated the Katraj Ghât and parts of the Guzerat and Khandesh Districts.

SOUTHERN INDIA.—The principal systematic survey work was done in the Anamalai forests by the Government Botanist and an Assistant. Similar work was also undertaken in the coffee zones of the Mysore forests. Collections were also made during the course of agricultural and economic tours in Malabar, on the Mysore Ghâts, and in the Coimbatore District. From the

Ganjam District Mr. C. E. C. Fischer,-Deputy Conservator of Forests, has contributed an interesting collection.

PUBLICATIONS.—The following publications have been issued during the year in connection with the Botanical Survey :—

(1) Records of the Botanical Survey, Vol. II, No. 4. *Flora of the Sundribuns*, by D. Prain.

(2) Records of the Botanical Survey, Vol. II, No. 5. *A Census of the Indian Polygonums*, by A. T. Gage.

In connection with the Royal Botanic Garden, Calcutta, was issued :—

Annals of the Royal Botanic Garden, Calcutta, Vol. X, Part 2. *The species of Dalbergia of S. E. Asia*, by D. Prain.

Non-official publications or papers by officers now or formerly connected with the Botanical Survey include :—

(1) *Flora of the Bombay Presidency*, Vol. II, Part I, by T. Cooke.

(2) *Eleiotis trifoliolata; Hooker's Icones Plantarum*, Vol. XXVIII, pt. 2753, by T. Cooke.

(3) *The trees and shrubs of the Lonavla and Karla groves* ; Journ., Bombay Nat. Hist. Soc., Vol. XV, p. 279, by G. A. Gammie.

(4) *Materials for a Flora of the Malayan Peninsula*, No. 14, Journ., As. Soc., Beng., Vol. LXXII, Part 2, p. 111, by Sir George King and J. S. Gamble.

(5) *Some additional Scrophularineæ;* Journ., As. Soc., Beng., Vol. LXXII, Part 2, p. 11, by D. Prain.

(6) *Notes on Sundribuns Plants;* Proc., As. Soc., Beng., for 1903, p. 107, by D. Prain.

(7) *Bengal Plants*, two volumes, by D. Prain.

(8) *Four interesting Bombay Plants;* Journ., Bomb. Nat. Hist. Soc., Vol. XV, p. 363, by G. M. Woodrow.

Papers dealing with Indian Botany by other writers published during the year include :—

(1) *List of Marine Algae collected at the Maldive and Laccadive Islands*, by J. S. Gardiner; Journ., Linn. Soc., Vol. XXXV, p. 475, *by* E. S. Barton.

(2) *Holigarna nigra, a new species;* Ind. Forester, Vol. XXX, p. 95, by J. F. Bourdillon.

(3) *A note on Gelsemium elegans;* Pharm. Journ., Vol. LXX, p. 868, by Sir D. Brandis.

(4) *The Bamboo fungus of Burma;* Pharm. Journ., Vol. LXX, p. 868, by Sir D. Brandis.

(5) *Contribution a la flore de l'Asie orientale;* Bull. Soc. Bot. de France, Vol. L., p. 547; Vol. LI, p. 56; p. 130, by Finet et Gagnepain.

(6) *Jatropha Curcas;* Journ., Bomb. Nat. Hist. Soc., Vol. XV., p. 365, by F. Gleadow.

(7) *Bulbophyllum auricomum;* Bot. Mag., Vol. LX., pt. 7938, by W. B. Hemsley.

(8) *Iris Collettii, Impatiens falcifer, Agapetes Moorei, Sauromatum brevipes;* Bot. Mag., Vol. LIX, pls. 7889, 7923, 7928, Vol. LX, pl. 7940, by Sir J. D. Hooker.

(9) *The Ferns of North-Western India, Part III.—The General List;* Journ., Bomb. Nat. Hist. Soc., Vol. XV, p. 78, and p. 415, by C. W. Hope.

(10) *The Poisonous Plants of Bombay*, Part XX; Journ., Bomb. Nat. Hist. Soc., Vol. XV, p. 56 (with plate), by K. R. Kirtikar.

(11) *Dioscorea daemona* Roxb.; Journ., Bomb. Nat. Hist. Soc., Vol. XV, p. 366, by G. M. Ryan.

Of the publications above enumerated, the more important ones are :—

The species of Dalbergia, and *Bengal Plants*, by D. Prain; the *Flora of the Bombay Presidency*, by T. Cooke; and the *Materials for a Flora of the Malay Peninsula*, by Sir George King and J. S. Gamble.

XV. Applied Botany.—I. PLANT PATHOLOGY.—Mr. Barber, Government Botanist, Madras, has investigated the diseases of Andropogon Sorghum (Cholam or Jowar) in Madras Presidency. The chief diseases found were smuts, rust, red leaf spot, shredding of the leaves and some other fungus diseases and several insect pests. Suggestions for treatment were given in most cases. In a note published by the same officer on the Experimental Sugarcane Station at Samalkot practical recommendations were given for diminishing the attacks of the Red rot of sugarcane caused by *Colletotrichum falcatum*.

The Cryptogamic Botanist toured to investigate diseases of the following plants locally. Coffee in Mysore, where much damage is done by disease. Stump-rot (species of *Rosellinia*) is common but may be much mitigated by the adoption of simple measures. Leaf disease *Hemileia vastatrix* and black rot (*Pellicularia Koleroga*) cannot so far be directly treated profitably but are sometimes lessened by high cultivation and drainage. An undescribed rust (*Aecidium sp.*) was found at Saklespur, where it causes a limited amount of damage.

Betel Nut (*Areca Catechu*) is attacked in Mysore by a rot (*Phytophthora sp.*) which causes very great losses.

Sandal wood in Mysore is still being steadily destroyed by "spike" disease which is spreading slowly, being partly checked by the measures recommended. It has however entered Madras Presidency at Kollegal. It was established that diseased trees serve as foci whence the disease spreads, but their removal was not found to be always successful in stopping this, either because all the roots cannot be taken out, or because the damage is done before distinct signs of the disease become visible. Over 200 inoculations were made, none of which were successful. The mode of infection therefore, and the exact nature of the disease, which is in many respects unique and for which no parasitic origin can be assigned, are still unknown. In Coorg where early and strenuous efforts were made by the Forest Department extension has been largely prevented. But within the affected area there is no diminution apparent in the severity of the disease.

Sugarcane in Bengal was found suffering from a variety of fungus diseases. About a dozen of these were investigated and an illustrated account prepared for publication. Red rot (*Colletotrichum falcatum*) is undoubtedly the worst. It appears to be spread primarily by the use of diseased sets, but this point is still under investigation. The injurious effects of the fungus are due to the development of a sugar-inverting ferment whose action was tested in conjunction with the Agricultural Chemist to the Government of India.

Wheat and Barley rusts were still under investigation. Much of the experimental work was done at the Cawnpore Government Experimental Farm with the assistance of Mr. J. M. Hayman, Deputy Director of Agriculture, United Provinces. Three rusts occur commonly on wheat, two of which also attack barley. The fungi concerned were identified, and their distribution over a large area of Northern India ascertained. The origin anew each year of the disease is a problem presenting many difficulties. Other plants attacked by the same fungi were examined and their influence shown to be slight. Experiments were continued to test the theory that the disease is hereditary; the specialisation of some of the races of the parasites on different plants proved; and the meteorological conditions influencing the disease examined. The bearing of these results on the production of rust resistant wheats is considerable.

The wilt disease of Arhar (*Cajanus indicus*) was found widely spread through several provinces. It has proved intractable to treatment in Bombay and a search is being made for a resistant variety. Ground-nut leaf disease was sprayed with Bordeaux mixture but the results of the treatment are not yet known. In jowar two distinct smuts were found, *Ustilago Sorghi* and *U. Reiliana*. The former has been successfully treated by steeping in copper sulphate solution. The read leaf spot of jowar was found to be caused by a fungus not identical with that of sugarcane red-rot as was at one time feared. Hence there is no danger to sugarcane from the vicinity of diseased jowar fields. Smut of Sawan (*Panicum frumentaceum*) was found in Madras and rust of Kangni (*Setaria italica*) in several provinces. The collection of rusts and smuts of fodder and other plants was continued.

About 80 different diseases of crops due to fungi were sent in for examination to Dehra Dun and recommendations for treatment given in most cases. Some of the more important were leaf diseases of Sisal hemp (*Colletotrichum Agaves*), Rust of Castor (*Melampsora Ricini*), Anthracnose (*Sphaceloma ampelinum*) and Mildew (*Uncinula necator*) of grape vines, white ear disease of rice (*Phoma glumarum*), rot of suran (*Rhizoctonia*), leaf diseases of turmeric (*Exoascus sp.*), Rust of Lucerne (*Uromyces striatus*).

A number of diseases of fruit and forest trees were investigated, the chief being Peach leaf curl (*Exoascus deformans*), Plantain leaf disease (*Macrophoma Musae*), Mango and loquat leaf spot (*Pestalozzia sp.*), Teak rust (*Uredo Tectonae*), Cypress rust (*Gymnosporangium Cunninghamianum*), a Casuarina disease (*Trichosporium aterrimum*), a deodar disease (*Fomes annosus*), a Babul disease (*Fomes Pappianus*).

Some progress was made with the formation of a herbarium of Indian fungi.

Work on the significance of the plant organs known as mycorhizas was continued.

The following publications dealing with plant pathology were issued:—

(1) *A Report on the Pepper vine disease in South Wynaad;* Proceedings of the Board of Revenue, Madras, 7th July 1903, by C. A. Barber.

(2) *A Deodar Disease in Jaunsar;* Indian Forester, appendix series, November, 1903, by E. J. Butler.

(3) *The Indian Wheat Rust Problem, Part I,* 1903, by E. J. Butler.

(4) *Diseases of Andropogon Sorghum in the Madras Presidency,* 1904, by C. A. Barber.

(2) Economic and Agricultural Botany.—(*a*) *Cereals, Food Stuffs, and fodders.*—The difficult enquiry into the characters and distribution of the various Indian yams on which the Director of the Botanical Survey and the Reporter on Economic Products have been for some seasons steadily engaged has made satisfactory progress, and part of the result is in the press. The Government Botanist, Madras, gave much attention to the experimental cultivation of sugarcane at the Samalkota sugarcane farm, with a view to the improvement of the local jaggery. The crops of the Coimbatore district were also investigated by the same officer. The investigation on the varieties of *Andropogon Sorghum* by the Reporter on Economic Products is very near completion. The species of Coix (Job's tears) have formed the subject of investigation by Sir George Watt, who has published a review of all available information in the Agricultural Ledger. Other subjects under investigation by the Reporter on Economic Products either alone or in conjunction with other officers include a study of the Barleys of India, an enquiry into the poison of *Lathyrus sativus*, what kinds of the grain are poisonous and where these are grown. An *ad interim* report on this subject has been prepared by Professor Dunstan. A review of existing information regarding the history, cultivation, and uses of the Tapioca plant has been published by the Reporter on Economic Products.

(*b*) *Gums, Resins, Rubber.*—The enquiry by the Reporter on Economic Products into the nature of the various Indian Gum Acacias is proceeding. A dammar of second quality from *Hopea odorata* has been found in Tenasserim. Professor Dunstan's report on it has been published as a commercial circular. The experimental Rubber Plantations under the Forest Department during 1903-1904 included nearly 3,000 acres of *Ficus elastica* in Assam, of which over 5,600 trees were tapped yielding 9,283 lbs. of rubber, giving an average of 27·5 lbs. per acre. In Bengal there were 30 acres of *Ficus elastica*. The experiments with Hevea Castilloa and Kickxia trees were unproductive. It is proposed to extend the area of plantation gradually to a total of 1,000 acres. Experiments on a small scale with various rubber-yielding species have been undertaken in Madras. In Burma the important experimental plantations of Hevea brasiliensis established in Tenasserim have been increased and there are now over 1,500 acres planted up mostly with Hevea. The prospects in respect of the cultivation of Hevea are considered to be generally favourable. The rubbers obtained from *Chonemorpha macrophylla, Cryptostegia grandiflora* and *Rhynchodia Wallichii* have been reported on by the Imperial Institute, the first unfavourably, the second two favourably. The latices of nine species of Ficus were analysed.

(*c*) *Dyes and Tans.*—Samples of the bark and leaves of *Baccaurea sapida* from Sylhet were sent to the Imperial Institute for investigation. A review of existing information on *Bixa Orellana*, the Annatto-dye plant has been published by the Reporter on Economic Products. Dried flowers of *Hibiscus Sabdariffa* were sent to Professor Hummel through the Imperial Institute. Professor Hummel died with the work incomplete, but it has been arranged by Professor Dunstan that the investigation shall be prosecuted. The enquiry into *Rubia khasiana* has been closed. Materials for the investigation of the dyes yielded by *Onosma echioides*, *Symplocos spicata* and *Thespesia Lampas* have been sent to the Imperial Institute. The collection of materials for reports on the dyes of *Mallotus philippinensis* and several species of *Morinda* has been completed. The Imperial Institute reports that the sample of *Cæsalpinia coriaria* from the Sonthal Pergunnahs is a good product, far better than any specimen previously forwarded from India and worth £8-10 to £11 per ton in London. The experiments in the manufacture of tannin extracts were continued by the Forest Department in Rangoon, and it was decided to make an experimental babul plantation of 1,000 acres near Cawnpore to provide bark for tanning.

(*d*) *Drugs, Narcotics, and Poisons.*—The drug furnished by *Adhatoda Vasica* and a syrup made from the leaves of *Cassia montana*, which were offered amongst samples of Senna in London, are under experiment by the Indigenous Drugs Committee. The consignment of bark of *Datisca cannabina* sent to Professor Marchlewski of Cracow was found to be very deficient in the amount of glucoside it contained. More material is being collected. Materials for the investigation of the products yielded by *Gynocardia odorata*, and the species of *Hydnocarpus* and *Datura*, are being collected. A supply of material of *Hyoscyamus niger* furnished by the Superintendent of the Botanic Gardens, Saharanpur, has been sent to the Imperial Institute for investigation of its properties. The collection of Indian opiums is completed. Of the very large collection of samples sent to the Imperial Institute only three small samples from Jaipur State have been reported upon. The report on the physiological action of Indian powdered opium is also due from the Imperial Institute. When the Board of Revenue, Lower Provinces, arranged for the representation of a set of the opium alkaloids in the Imperial Institute, the opium officers expressed a desire that the Research Department would suggest improved methods of separating the alkaloids. No suggestions have as yet appeared.

(*e*) *Fibres.*—The Inspector General of Agriculture has given special attention to the improvement of Indian cotton. His enquiries include investigations into :—

(1) The characteristics and comparative values of the indigenous varieties and their adaptiveness for various descriptions of soil and climate. (2) The improvement of indigenous varieties by seed selection and cross fertilisation. (3) The value of exotic varieties for various descriptions of soil and climate, and the effects of acclimatization. (4) The reasons why the cultivation of some inferior indigenous varieties has extended and that of some long-stapled varieties has declined. (5) Deterioration of indigenous varieties. (6) Whether cultivators are deterred from growing long-stapled or fine cotton because they do not get remunerative prices. (7) The means of introducing improved varieties into general cultivation. (8) Whether different varieties are mixed in ginning or baling, and whether such admixture is done for legitimate trade requirements or for fraud.

From the agricultural point of view the Indian varieties of cotton may be broadly grouped into :—

(*a*) varieties which take at least eight months to come to maturity

(*b*) varieties which ripen in about five months.

The varieties of the first group as dry crops are suited only for districts with deep moisture-holding black soil or such as have a prolonged rainy season, as in parts of Bombay and Madras Presidencies where the influence of the two monsoons is felt. The varieties of the second group are much more numerous than those of the first, and are widely cultivated in every province of India except Madras. With few exceptions the cotton produced from these second

group varieties is short and coarse, but pure white in colour, with a high percentage of lint to seed, in contradistinction to the cotton of the first group of varieties, which has a percentage of lint to seed varying from over 40 per cent. to under 25 per cent.

It has been proved by experiment that the length and quality of lint and its percentage to seed are improved by superior cultivation and seed selection. Cross-breeding experiments are now in progress to produce from late ripening varieties crosses which have greater vigour of growth and productiveness than the parents, and to produce from the best late and best early ripening varieties vigorous crosses which will ripen nearly as soon as the early ripening parents. Experimental cultivation of exotic varieties has not so far yielded very promising results.

The extension of cultivation of inferior varieties is apparently due to the fact that the inferior varieties can be grown on soil unsuited to the better varieties and with less risk in average years than the latter, and they are also quicker in growth. The Inspector General of Agriculture is of opinion that undoubtedly deterioration of indigenous varieties of cotton has occurred, and he attributes this deterioration to a variety of causes, such as continued cultivation from the same strains of seed for many generations, to carelessness in seed selection and in cultivation, and to impoverished soil. The Inspector General also states that it is not correct to say that there is no difference in price made by the dealers between inferior and superior varieties of cotton. There is a big difference in price between fine quality cottons such as Surat and inferior short-stapled cottons, classed as "Bengal" by the traders.

Experiments carried out during the year on the cultivation of jute show that jute should be cut for fibre before it is dead ripe, and that liberal cultivation and probably also rotation of crops, result in a better outturn of fibre. There is no proof of any degeneration in jute plants having occurred during the last hundred years. The occurrence of much inferior fibre in the market appears to be due to the fact that, whereas formerly only the best jute, or at all events the jute most suitable for purposes of the Dundee and Calcutta spinner, alone found a sale among jute dealers, now these dealers require so much jute that to fulfil their obligations they must purchase practically whatever jute is offered to them, knowing as they do that what one dealer refuses to buy, another will come forward and secure.

The Reporter on Economic Products has studied the cottons of Burma and prepared a report on them. The Director of the Botanical Survey has conducted an enquiry into the sources of Indian Hemp fibre. Seeds from many parts of India were cultivated with the result that the fibre was shown in each case to be the product of *Crotalaria juncea*. The same officer aided by the Reporter on Economic Products and other officers has instituted a sustained enquiry into the identity and distribution of the various *Agaves* and *Furcraeas* that are naturalised in different parts of India. A preliminary report by the Director of the Botanical Survey and Mr. J. R. Drummond, I.C.S., is in the press. Samples of the fibre yielded by various species of Calotropis have been forwarded by the Reporter on Economic Products to the Imperial Institute for investigation. The same officer has also been engaged upon a very large investigation upon Plantain fibres. A report on the fibre of *Marsdenia tenacissima* has been published as an Agricultural Ledger.

(*f*) *Miscellaneous.*—The Forest Department has conducted an enquiry into the manufacture of wood and bamboo pulp for paper-making, and enquiries are now being made regarding the starting of experiments in Burma with a view to developing the industry. More than a score of sets of timber specimens were prepared by the same Department in connection with the *Manual of Indian Timbers*. A circular has been issued by the Reporter on Economic Products showing as the result of analysis that the charred rice husks from rice mills in Burma is worth using as a dressing to land.

Professor J. C. Bose has studied the electrical phenomena exhibited by plants under certain conditions, and has published two papers in the Journal of the Linnean Society on this subject.

The following papers dealing with Economic and Agricultural Botany have appeared during the year.

Note on the experimental sugar-cane station at Samalkot, Godavari District, by C. A. Barber.

The Agricultural Ledger—

1903, No. 5.—*Pulses of India.*
„ „ 7.—*Food grains and fodder.*
„ „ 10.—*India Rubber.*
„ „ 11.—*Hibiscus Cannabinus.*
1904, No. 1.—*Aquilaria Agallocha*
„ „ 2.—*Sapium sebiferum.*
„ „ 5.—*Shorea robusta.*
„ „ 6.—*Famine foods.*
„ „ 7.—*Indian Beeswax.*
„ „ 8.—*Marsdenia tenacissima.*
„ „ 10.—*Manihot utilissima.*
„ „ 11.—*Carthamus tinctorius.*
„ „ 12.—*Bixa Orellana.*
„ „ 13.—*Coix spp.*

XVI. **Chemistry**—(1) PURE CHEMISTRY.—An investigation has been conducted by Professor E. G. Hill of Allahabad into the constituents of *Reh.* Samples from various districts were analysed, and the results showed that Reh is an impure Sodium Carbonate containing small quantities of Sodium Chloride and Sodium Sulphate. Traces of phosphates and alumina could also usually be detected.

The colouring matter of the flowers of *Butea frondosa* has been studied by Professors Hill, Hummel and Perkin. The first named discovered that from the aqueous extract a yellow colouring matter giving reactions similar to those of Fisetin could be obtained. The two latter analysed the tri-benzoyl and tri-acetyl derivatives of the yellow compound and made suggestions as to the chemical constitution of the new colouring matter to which the name *Butein* was given.

More recently Professor Perkin has demonstrated that Butein has the constitution C_{15} H_{12} O_5 and is probably tetrahydróxy-benzylidene-aceto-phenone. A colourless isomer also exists in the aqueous extract of the flowers of *Butea frondosa,* to which Professor Perkin gives the name *Butin.* This is probably a Flavone derivative.

Investigations on the distillation of *Chlorine* were carried out by Dr. A. Richardson of Benares Central Hindu College. His results showed that when Chlorine water is distilled it undergoes partial change with formation of Hypochlorous and Hydrochloric acids. When the separation of the two acids is prevented, chlorine water is practically stable at the boiling point. The amount of change decreases as distillation proceeds, owing to the formation of Hydrochloric acid in the original solution. In the presence of a large excess of the acid only free Chlorine passes over in the distillate.

In the Calcutta Presidency College Professor Stapleton and Babu Bidhu Bhusan Datta investigated the synthesis of *Hydrazine.* The latter also assisted Professor Cunningham of the same College by preparing various organic bodies with a view to determining the physical conditions that govern the formation of substituted and additive halogen derivatives of the Hydrocarbons.

Dr. P. C. Ray and Babu Jatindra Nath Sen investigated the decomposition of mercurous nitrite under the influence of heat. They discovered that the decomposition was analogous to that of Silver nitrate and concluded that their experiments pointed to the existence of mercurous nitrite in two tautomeric forms, *viz.*, Hg N O_2 and Hg O NO. Mr. Hooper, Curator of the Industrial Section of the Indian Museum, studied the chemical constitution of various naturally occurring sulphates from Baluchistan.

Dr. Leather studied the available plant food in soils, and the amounts of combined Nitrogen in Rain, Dew and Drainage water at Cawnpore and Dehra Dun. The amount of Nitrogen in rain water works out to be about 4lbs. per acre, which is similar to that of other countries, but the amount of Nitrates in drainage water has proved to be unusually high. It is intended to conduct this research on lines parallel to those of the analogous series of experiments carried out at Rothamsted during the latter half of last century.

2. APPLIED CHEMISTRY.—Dr. Leather has continued his studies on the chemical composition of Indian food grains and fodders, and has published his results in the Agricultural Ledger series. Mr. D. Hooper, Curator of the Industrial Section of the Indian Museum, has investigated the chemcial composition of the fats of *Sapium sebiferum*, the Chinese tallow tree. He has also made analyses of Indian pot-herbs of the natural orders Amaran taceæ, Chenopodiaceæ, and Polygonaceæ, and studied the composition of the Beeswax of British India, also the properties and chemical composition of Burmese Storax, derived from *Altingia excelsa*. The chemical composition of the fruits of *Ficus bengalensis*, *Ficus Cunia*, *Ficus glomerata*, *Ficus religiosa*, and of the seeds of 'sal,' *Shorea robusta* has been determined by Mr. O. Reinherz.

Cyanogenesis in plants.—Since Dunstan and Henry published their work on the glucosides *Lotusin* of Lotus arabicus and *Dhurrin* of Sorghum vulgare, several other similar substances have been met with. The same authors have separated the glucoside *phaseolunatin* from the beans of wild *Phaseolus lunatus*. It is accompanied by an enzyme which hydrolyses it when the beans are crushed and moistened with water, and hydrogen cyanide, dextrose and acetone are formed. They did not find this glucoside in the seed of the cultivated variety of the plant. (Pros. Roy. Soc. 1903, *72*, 285-294). Power and Gornall have isolated a similar glucoside from the seeds of *Gynocardia odorata* which they name *Gynocardin*. This is associated with an enzyme capable of hydrolysing it with the formation of hydrogen cyanide. (Pros. Chem. Soc. 1904, p. 137.) In relation to the presence of *Dhurrin* in *Sorghum vulgare*, Brunnich of Brisbane has determined the quantity of prussic acid obtainable from the plant at various stages of growth, and found that (in the crop growing in the Brisbane Botanic Garden) it decreased rapidly with maturity. Sun drying the fodder does not destroy either dhurrin or its enzyme. He also found that other fodder plants, "Kaffir corn," "guinea grass," *Panicum maximum*, and *P. muticum* each contained a substance similar to dhurrin. Sugar-cane tops, *Paspalum dilatatum*, and *Cynodon dactylon* were found free from such glucosides. (Jour. Chem. Soc. Vol. LXXXIII, p. 788 et seq.) But the occurrence of dhurrin in *Sorghum vulgare* (*Andropogon Sorghum*) is not nearly so regular as might be supposed from published records. In June of the present year the work cattle at one of the Poona Farms were suddenly attacked with very serious illness and two died. The fodder was sent to the Dehra Laboratory and Dr. Leather found it to contain a very high proportion of the glucoside. 1·29 grain of prussic acid per pound of fodder was obtained from the first portion examined; and ·99 from another portion. The leaves contained more than the stalk. Another sample from the same field a month later yielded ·75 grain per pound of fodder. This experience coincides with that of Dunstan and Henry and Brunnich. But fodder obtained at the same time from a village near the Poona Farm yielded only ·17 grain. Other specimens of this plant growing at Dehra contained even less. One specimen tested in July, 2′ 9″ high yielded ·25 grain. Two varieties "Utavali" and "Nilva" obtained from Poona in July and grown at Dehra, yielded ·35 and ·25 grain when very young, and none at all when approaching the flowering stage. The evidence thus obtained this year in India points rather to the formation of the glucoside in excessive quantity in isolated cases. It may be more readily formed in one variety than in another, but there seem to be other controlling conditions as well.

Tapioca Roots.—Prussic acid has been constantly met in the examination of this root, and the general conclusion has been drawn that it is generally present in certain varieties. A careful set of experiments carried out during the current year by Dr. Leather showed that in the roots examined at Poona and Dehra there is *no* free hydrogen cyanide at all, but that it is generated by enzymic action from a glucoside. This work is in progress. The colour of the stem or leaves has no relation to freedom or otherwise from the glucoside.

Calcium Cyananide.—This substance was first produced about three years ago by Siemens and Halske by passing atmospheric nitrogen gas (after being freed from oxygen) over calcium carbide in the electric furnace.

It has a prospective value as a source of ammonia, and cyanides, and experiments have been made with it as a fertiliser. In some of their experiments, Gerlach at Posen and Wagner at Darmstadt have found it to possess a high value in the latter respect, whereas in other experiments it has proved to be defective. Doubtless much more information concerning it will become available shortly, as it is being tested at a number of places. As it can be produced at present for about the same price as sulphate of ammonia, and has proved itself so efficacious in some experiments, there is every reason why attention should be paid to it. Should it succeed, it will provide the cheapest known means of bringing atmospheric nitrogen into combination for industrial purposes. With a prospect of extension of electric power in India the possibility of adding this substance to the list of uses to which the power may be put is important.

Sewage.—The agricultural value of city sewage is being tested near Poona, and in connection with this experiment Dr. Leather has carried out a series of tests to determine the rate of purification in the septic tank and "contact" beds. In the former it has been found that the length of time required for the changes to take place depends largely on the strength of the sewage, a weak sewage requiring, per unit volume, a smaller tank than a strong sewage. The length of this period, however, does not increase in the same proportion.

Indigo.—A valuable contribution to our knowledge of the formation of indigo from *Indigofera sumatrana* has been made by Bergtheil in which he shows that the dye is produced from a glucoside in the leaf by the agency of an enzyme. Several species of bacteria also appear to accompany the plant, which have a power similar to the enzyme, but he considers that the action is mainly due to the enzyme. (Jour. Chem. Soc., 1904, p. 870).

A contribution to our knowledge of *Indigotin* has been added by W. P. Bloxam, who advances evidence that the usual methods of estimating its quantity are imperfect on theoretical grounds. He also considers that the so-called indigo-red is a dye not derived from *Indigotin.* (Pros. Chem. Soc., 1904, p. 159.) L. Breaudat (Rev. Gén. mat. col. 1903, 7. [84] 357) considers that the water employed for extracting indigotin from the plant should be purified, best by the addition of lime, which process assists in providing a purer indigo. Rawson (Jour. Soc. Dyers & Colourists, 1904, *20.* 35) considers that the impurities usually present in natural indigo do not occasion any loss of indigotin during the drying of the due.

Tanning Materials. (*a*) *Mangrove bark.*—Paessler (Collegium 1904 [91] 15-16) gives details of the tanning properties of mangrove bark in comparison with oak, and urges the value of the former. In Impl. Inst. Bull. 1904. *2.* 163-6, the composition of specimens of this bark is given, and mention is made that leathers produced by this tannage were classed as "low grade boot leather." The bark is valued at £3-10-0 to £4 per ton at Glasgow.

(*b*) *Myrobolans.*—Parker and Blockley (Jour. Soc. Chem. Ind. XXII. 1181-4) detail the results of the experiments on the comparative tanning value of myrobolans from different sources. The specimens were marked "Bhimly," "Rajpore," "Jabalpore," "Vingorlas," and "Fair coasts Madras." They found "Bhimlies" stood first in their acid-producing power, while "Jabalpore," and "Vingorlas" yielded the best bloom.

(*c*) *Divi-divi.*—(Imp. Inst. Bull. 1904, 2. 92-3) shows the comparative richness of divi-divi from India and Queensland in tannin, the former containing from 48 to 68 per cent., the latter (one sample) 68 per cent.

(*d*) *The Tannin of Catechu* has been extracted by W. E. Ridenour (Jour. Franklin Inst. 1903. *156* [6] 417) in the pure state, in which method the catechin is removed by ether, and the tannin by acetic ether. It is reddish brown coloured. Another process for the extraction of tannin has been patented by A. Thompson in which the liquor, after treatment with sulphurous acid, is extracted with methyl alcohol.

The decolorisation of tannin extracts has been the subject of a patent by Clowes and Hatschek in which inert yeast cells are employed.

Fibres

Agave americana so-called from Assam, and *Marsdenia tenacissima* from Bengal have been examined at the Imperial Institute. The latter was found to be the better though the fibre is shorter (Impl. Inst. Bull. No. 3, 120-3).

Paper.

Sugar-cane bagass.—Experiments carried out in Java on the value of the bagass or crushed sugar-cane as a paper-making material showed it to possess good strength and colour and value higher than straw pulp. That this material has not found a larger market for the purpose is attributed to industrial and economic difficulties (Papier Zeit. 28. [81] 2891). *Bamboo pulp* is the subject of a paper by C. D. Ekman (Wochenbl. f. Papier fab. 1904. 35, 461-2) who urges its value as a paper pulp material, its fibre being equal to the best cotton pulp. The pulp must be prepared where the cane grows owing to cost of transit of the whole cane. It requires rather a high proportion of bleaching powder. Another material recommended for this purpose is the fibrous bark of the "Lace" wood of Indo-China. Further attempts have also been made to utilise cotton seed hullings for paper pulp.

Oils.—The characteristics of several Indian oils have been examined by J. Lewkowitsch (Analyst 1903. *28*, 342-4). The list includes "pangam" of *Pongamia glabra*, which he considers might be used in the soap and candle industries; "Margosa" or "Neem" oil of *Melia azadirachta* and "Ben" oil of *Moringa pterygosperma* (M. oleifera). The latter is used for lubricating delicate machinery such as watch springs. The oils of *Robinia pseudacacia* and *Caragana arborescens* seed have been examined by V. Jones (Mitt. d. Kaiserl. Konigl. techn. Gewerbemuseum in Wien. 1903. *13*. 223-7), who found them to be drying oils, the former similar to linseed and the latter to hemp. The seeds, however, contained only about 12 per cent. of oil.

Essential Oils.—The essential oil of *Acacia Farnesiana* has been examined by H. Walbaum (J. Prakt. Chem. 1903, 68, 235-250).

Cotton Seed Cake.—In connection with the cotton seed cake made from Indian seed, some experiments were carried out by Gilchrist at the Durham College of Science, which showed it to possess a feeding value not inferior to Egyptian cake and no harmful effects were noticed from its somewhat "woolly" character (Jour. Bd. of Agricl. XI. 289). It seems unlikely that further objections will be made to the use of this cake, for in addition to the above evidence, the seed is generally fed to cattle in India with safety.

Rubber.—Some experiments carried out by Mylins tend to show that the coagulation of caoutchouc latex should be best effected by small quantities of complex acids such as hydroferrocyanic and tungstic rather than by simpler ones. (C. O. Weber Gummi Zeit. 1903. *17*, 652).

A. T. GAGE,

Acting Secretary, Board of Scientific Advice.

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